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РЕЗЮМЕ

ДАННЫЕ К АНАТОМИИ КРАСНОГО ПЕРЦА (CAPSICUM ANNUUM L.)

III. Сравнительное исследование эндокарпия

И. КОНЕЧНИ

Изучался эндокарпий у разных сортов пряного и столового перца. Клетки эндокарпия формируются двумя путями. Между клетками паренхимы имеются каменистые клетки. Ямообразно утолщенные каменистые клетки создают острова, группы клеток в эндокарпии. На жилкованиях каменистые клетки находятся в большинстве случаев в виде маленьких групп, и рассеянно. Установлена средняя величина и форма каменистых клеток и их островов у самых важных сортов пряного и столового перца.

РЕЗУЛЬТАТЫ ОПЫТОВ ПО УНИЧТОЖЕНИЮ СОРНЯКОВ СОРГО ГЕРБИЦИДАМИ В ВЕНГРИИ С 1955 ПО 1970гг

Э. КЮКЕДИ

Работа содержит результаты опытов, проведенных с 1955 до 1970г по уничтожению сорняков сорго*(Sorghum vulgare* var. *frumentaceum, Sorghum vulgare* var. *saccharatum, Sorghum vulgare* var. *sudanense)* с использованием гербицидов. На основе экспериментов и производственных опытов, проведенных до сих пор, выяснилось, что **Atrazin** и **Ramrod** являются самыми подходящими для уничтожения сорняков у зернового сорго на хорошо культивированных почвах. Предложенная доза при наших условиях 4 + 4 кг/га **Atrazin.** 5 кг/га также дал хороший результат у сахарного сорго. 2,4 Д использовалось для уничтожения сорняков у суданской травы в дозе 1,75 кг/га, в форме опрыскивания.

ГИСТОГЕНЕТИЧЕСКОЕ ИЗУЧЕНИЕ ЭКЗОКАРПИЯ, МЕЗОКАРПИЯ И ЭНДОКАРПИЯ МИНДАЛЯ

Ж. АНТОНИ

В наших гистогенетических исследованиях индивидуальные слои околоплодника миндаля оказались не простыми эквивалентами разных слоев завязи. Экзокарпий происходит из внешнего эпидермиса завязи. С другой стороны, он не представляет собой весь мезофилл, а является только его внешней половиной, абаксиальной частью завязи, из которой развился мезокарпий. Эндокарпий является самым сложным, имеет двойное происхождение, развившись частично из мезофилла, частично из внутренней части эпидермиса.

КУРЧАВОСТЬ ЛИСТЬЕВ У ПЕРЦА

ЖОЗЕФИН К. ЭСКАРОУС

Были найдены естественно зараженные растения перца (**Capsicum frutescence var. grossum**). Листья имели различные симптомы мозаичной пятнистости, пузырчатости, уродства, искривлений, а также курчавость верхушек и зигзагообразность средней жилки листа. Зараженные растения были более компэктными по росту, чем нормальные растения. Плоды зараженных растений были более мелкими по размеру и слегка искривленными. Вирус был полностью инактивирован при 94°С, имел конечную точку разбавления немного выше 10^{-6} и заражал в течение 50—55 дней при комнатной температуре (23—28°С). Серологические реакции против табачного мозаичного вирусного антисерума показали, что вирус был табачным мозаичным вирусом. Вирус, вызывающий курчавость листьев перца, может быть рассмотрен как штамм табачного мозаичного вируса.

ИСПОЛЬЗОВАНИЕ СТИМУЛИРУЮЩИХ КОРНЕОБРАЗОВАНИЕ АЛЬФА-НАФТИЛ-УКСУСНОЙ, А ТАКЖЕ БЕТА-ИНДОЛИЛ-МАСЛЯНОЙ КИСЛОТ ПРИ РАЗМНОЖЕНИИ ЧЕРЕНКОВ СМОРОДИНЫ

С. КАЛМАР

Импортные сорта смородины из разных стран были размножены зелеными и полуодревесневшими черенками. Перед черенкованием использовали стимулирующие корнеобразование альфа-нафтил-уксусную и бета-индолил-масляную кислоты в разных концентрациях. Установлено, что при размножении зелеными черенками обработка сорта **Jonkheer van Tets** 3000 ппм бета-индолил-масляной кислотой и сорта **Red Lake** 5000 ппм бета-индолил-масляной кислотой дали самый лучший результат. При размножении полуодревесневшими черенками обработка сортов **Jonkheer van Tets** и **Red Lake** 3000 ппм бета-индолил-масляной кислотой оказалась наилучшей. Несмотря на тщательно проведенную обработку, сорта **Macheraus Späte Riesen Traube** и **Groseille Raisin** погибли.

ВЛИЯНИЕ ТЕМПЕРАТУРЫ НА ЦВЕТЕНИЕ ВЕНГЕРСКОГО АБРИКОСА

Л. МОЛНАР, А. ШТОЛЛАР

Состояние глубокого покоя в плодовых почках абрикоса — на основании суммы температур — в нашей области заканчивается в середине декабря. Для подсчета суммы температур, необходимой для цветения, наиболее используема эффективная средняя температура дня выше 3°С. Однако, действительный биологический ноль ниже этой температуры. Начиная с 16-го декабря, эффективная температура, необходимая для цветения абрикоса, со средней температурой дня выше 3°С, в среднем за 10 лет равняется 199,8°С, при среднем квадратическом отклонении 14,9° (7,5%).

СРАВНИТЕЛЬНОЕ ИЗУЧЕНИЕ СОДЕРЖАНИЯ БЕЛКА НЕСКОЛЬКИХ СОРТОВ ПШЕНИЦ, УЛУЧШЕННЫХ ПОД ВЛИЯНИЕМ АЗОТНОГО УДОБРЕНИЯ И ВРЕМЕНИ ПОСЕВА

А. АУСТИН, БАСАНТ КУМАР, Т. В. Р. НАИР

При существующей в настоящее время тенденции, при которой в программе селекции пшеницы больше внимание придается научной основе качества, чем морфологическим свойствам семян, содержание белка является одним из важнейших свойств качества семян. Пшеница и другие зерновые культуры являются главным источником белкового питания для индийских людей, среди которых превалирует недостаточное питание. Несколько улучшенных сортов, созданных индийскими селекционерами в настоящие годы, по содержанию белка, варьирующему от 10 до 16%, превосходят старые индийские пшеницы (AUSTIN и др. 1952, 1968). Некоторые из этих сортов проявили значительную реакцию на различные дозы азотного удобрения, производя увеличенное содержание белка (AUSTIN–MIRI, 1961). Эти результаты показывают возможность увеличения содержания белка в пшенице путем улучшения сорта и агротехники. Принимая это во внимание, большое число новых сортов анализировали по содержанию белка и изучали влияние на него азотного удобрения, сорта и времени посева.

КРУПНОЛИСТНАЯ СПОНТАННАЯ МУТАЦИЯ ЛЮПИНА ЖЕЛТОГО (LUPINUS LUTEUS L.)

Ф. БОРБЕЙ, И. БОРБЕЙ

В 1961-ом году авторы нашли новую крупнолистную спонтанную мутацию в сорте люпина **Gyulatanyai** 784. У потомков мутанта изучались морфологические особенности листа (листка), а также некоторые признаки в отношении урожайности, с целью предварительной ориентации. Вариация листка у мутанта сравнивалась с данными оригинального сорта. На основе вариационных анализов установлено, что размеры листков у исследованных вариантов сигнификантно различаются. Размер листков постепенно увеличивается по ряду: дикая форма — оригинальный сорт — мутант. Различия по длине по сравнению с оригинальным сортом + 15,3%, по ширине + 37,3%. Различие наблюдалось также по типу частоты ширины листка и по вариационной ширине. Далее установлено, что мутационное изменение повлияло не только на размер, а также и на форму листков. Листок мутанта оказалься шире по отношению к его длине, сравнивая с более длинными, узкими листками оригинального сорта. По исследованиям авторов урожайность зерна у мутанта оказалась меньше, чем у оригинального сорта. Показано однако, что одногодичные исследования являются недостаточными, поэтому установленные различия не могут рассматриваться как окончательные, и надо еще производить дальнейшие исследования с большим количеством растений. Вероятно новый мутант, в форме партнера при скрещивании, может стать ценным исходным материалом селекции.

ВЛИЯНИЕ БЫСТРЫХ НЕЙТРОНОВ В МАЛЕНЬКИХ ДОЗАХ И ГАММА-ОБЛУЧЕНИЙ НА ВЕНГЕРСКИЙ СОРТ РИСА

К. КАРУНАКАРАН, И. ШИМОН

Публикуются результаты эксперимента, выполненного в вегетационных сосудах- Обнаружено улучшение прорастания, стимуляция раннего роста проростков вместе с лучшим развитием корней и побегов под влиянием 50 и 100 рад. облучений. В проростках, обработанных маленькими дозами, увеличилось N—P поглощение. Продолжительность цветения оказалась неизмененной.

ВЛИЯНИЕ ВРЕМЕНИ ГОДА НА СОДЕРЖАНИЕ БЕЛКА И КАЗЕИНА В МОЛОКЕ

З. ШАШВАРИ

Изучалось влияние времени года на содержание белка и казеина в молоке у помесных коров: 50% венгерской пестрой породы × 25% датской джерси, контролем служила венгерская пестрая порода. В результате опытов установлено, что в некоторых исследованных стадах содержание белка и казеина в молоке оказалось наибольшим зимой, а наименьшим — летом, в июле и августе. Но это явление не было общим.

ГЕНЕТИЧЕСКИЕ ИССЛЕДОВАНИЯ НАСЛЕДУЕМОСТИ ЦВЕТА СЕМЕННОЙ ОБОЛОЧКИ КУНЖУТА

М. ОСМАН КИДИР, М. А. АЛИ

Значительная изменчивость цвета семенной оболочки наблюдалась у 26 сортов кунжута. Черный цвет доминировал над коричневым и белым, и коричневый цвет доминировал над белым. Черный и белый цвета контролировались двумя парами факторов, и дали расщепление 9 : 3 : 3 : 1 (черные и темно-серые, серые и белые) по цвету семенной оболочки в потомстве F_2. Подобно этому, коричневый и белый цвета управлялись двумя парами факторов, в результате чего получилось расщепление 9 : 3 : 3 : 1 (коричневые, светло-коричневые, серые и белые) в потомстве F_2. Скрещивания коричнево- и черно-семенных родителей показали моногибридное расщепление. Факториальная конституция родителей оказалась следующей: черный, ААББ; коричневый, ААб^{p}б^{p}; белый, аабб.

ИССЛЕДОВАНИЕ ЭНЗИМАТИЧЕСКИХ ПРИЧИН НЕСПОСОБНОСТИ К ПРОРАСТАНИЮ У СЕМЯН ГОРОХА. АКТИВНОСТЬ ПЕРОКСИДАЗЫ И КАТАЛАЗЫ

К. ЛАСЛО

Изучая причину неспособности к прорастанию со стороны удовлетворяющего, а также неудовлетворяющего действия энзимов, катализирующих процессы физиологии прорастения, приводится связь между прорастающей способностью и активностью пероксидазы и каталазы семян.

ЗАРАЖЕНИЕ OROBANCHE AEGYPTIACA PERS, ПОТЕРЯ ЭКОНОМИЧЕСКОЙ ЦЕННОСТИ РАСТЕНИЯ-ХОЗЯИНА, И БОРЬБА С ПАРАЗИТОМ

М. К. БАТТАЧАРИЯ

Заражение Orobanche влияет на все части растения-хозяина, о чем свидетельствует редукция сухого веса стебля и корня. За понижением урожая следует качественная деградация плодов растения-хозяина. Среди химических веществ, использованных в борьбе с этим паразитом, изоамиловый спирт, трихлоруксусная кислота и 2,4-D (соль Na) оказались довольно эффективными. У корневых растений появлялась определенная деформация. В острых случаях химические вещества оказали вредное действие на корневые растения.

ВЛИЯНИЕ АЗОТА НА УРОЖАЙ TRITICALE И НА СОДЕРЖАНИЕ МИНЕРАЛЬНЫХ ВЕЩЕСТВ

К. ПРОХАСКА, И. ЧЕРНИ, Б. ФЕХЕР II.

Изучалось влияние одностороннего применения азотного удобрения в возрастающих дозах на содержание главных макро- и микроэлементов, а также на урожай Triticale № 64. На основе экспериментов установлено, что одностороннее применение азотного удобрения в возрастающих дозах достоверно повысило содержание N, Mn и Mo в зерне Triticale, в то же время уменьшило содержание Ca и Zn. Содержание P, K, Mg, Fe и Cu в зерне не изменилось под влиянием азотного удобрения. В стеблях Triticale азотное удобрение изменило только содержание Mo и K, а именно: достоверно уменьшило в них содержание Mo и повысило содержание K. Под действием азотного удобрения урожай зерна и соломы достоверно повысился, что послужило причиной к повышению выноса микроэлементов из почвы.

РОЛЬ ВЕЛИЧИНЫ ЛИСТОВОЙ ПОВЕРХНОСТИ И ФОТОСИНТЕТИЧЕСКОЙ ПРОДУКТИВНОСТИ НА НАКОПЛЕНИЕ СУХОГО ВЕЩЕСТВА В РАСТЕНИИ РИСА

НГУЕН ВАН УЕН

С точки зрения фотосинтеза и продукции сухого вещества можно различать две главные фазы вегетативного периода у растения риса: период быстрого увеличения поверхности листьев и период увеличенной фотосинтетической продуктивности. Большая часть сухого вещества накапливается в семенах риса в течение второго периода. Для того, чтобы получить высокий и стабильный урожай, азот должен использоваться для регуляции роста листовой пластинки в первом периоде, и фотосинтетической активности во втором периоде.

ОТНОШЕНИЕ МЕЖДУ ЭВАПОТРАНСПИРАЦИЕЙ РИСА И ИСПАРИТЕЛЬНЫМ АППАРАТОМ

В. К. ВАМАДЕВАН

После двухлетнего изучения отношения между эвапотранспирацией и испарительным аппатаром—испаритель класса «А» и испаритель GGI 3000 — установлено, что отношение ET/E является почти постоянным для вегетативного и репродуктивного периодов, а также для периода созревания риса. Месячное и сезонное отношение «I» рекомендуется для территорий подобных тем, которые были включены в эксперимент. Не было сигнификантного различия между испарителями класса «А» и GGI 3000.

ВЛИЯНИЕ ГАММА-ОБЛУЧЕНИЯ НА КОЛИЧЕСТВЕННОЕ ИЗМЕНЕНИЕ СОДЕРЖАНИЯ УГЛЕВОДОВ В ПРОРОСТАЮЩЕМ ГОРОХЕ

Й. ФРАНК, З. ЛЕНДВАИ

Авторы исследовали влияние облучения на отношение между крахмалом и углеводами сахарного типа в семядолях гороха, в связи с началом прорастания. Установлено, что содержание всех углеводов в семенах увеличилось сразу на следующий день после облучения, но количество растворимых сахаров уменьшилось на 25 процентов. За этим понижением следовало увеличение на 10—20 процентов, и на девятый день у всех обработок растворимая углеводная фракция растений приблизилась к уровню сахара в необработанных растениях, или достигла его. В критическое время прорастания, на пятый или шестой день после поглощения воды, гидролизирующая деятельность амилазного комплекса сигнификантно увеличивалась, вследствие чего в обработанных сеянцах содержание сахара, относящееся на сухое вещество превзошло таковое у контроля на 2—8 процентов. Однако, на девятый день только у стимулирующих доз содержание углевода оказалось большим, чем у контроля.

ДЕЙСТВИЕ КОРМЛЕНИЯ РАЗЛИЧНОЙ ИНТЕНСИВНОСТИ НА РОСТ И СЕКСУАЛЬНЫЕ СПОСОБНОСТИ БЫКОВ-ПРОИЗВОДИТЕЛЕЙ

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Режим кормления одной из групп был на уровне, предписанным обоснованным стандартом (100 процентов), другой группе корма давали на 30 процентов меньше. Основываясь на результатах экспериментов, можно констатировать, что 30-процентное уменьшение уровня кормления в возрасте между 6 и 18 месяцами давало различие в весе тела, равное 10 процентам, Вследствие более бедного питания рост достоверно уменьшался, но относительны размеры тела в экспериментальной группе оказались более благоприятными. Уменьшени уровня питания не оказало действия на скорость и ритм роста, количество и качество спермы и эякуляционную способность. Лучшее переваривание корма было у 70 процентоб группы, причём различия по легкоусвояемому белку равнялись 20 процентам, а по крахмалу соответственно 25 процентам.

ОНТОГЕНЕТИЧЕСКОЕ ИЗУЧЕНИЕ РОСТА НЕКОТОРЫХ СОРТОВ РАЙГРАССА ПО СРАВНЕНИЮ С ЯЧМЕНЕМ

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Растения ячменя достигали своей максимальной высоты через 101 день после посева, в то время как райграссы к этому же времени достигали только 1/3—1/2 своей полной высоты. Ячмени сильно превосходили райграссы по площади листьев до 101 дн. после посева. Количество листьев, число побегов и площадь листьев достигали максимума у ячменя раньше, чем у райграссов, в то время как максимальная кустистость у райграссов была выше, чем у ячменя. Ячмень цветет на 8—10 дней раньше, чем сорта райграсса. Сухой вес растения ячменя, также как и сравниваемые его части, сильно превосходили райграссы в период до 101—111 дней, в то время как сорта райграсса достигали максимальных показателей позже, при этом сорта Westerwolds и Tetrone превосходили сорт Normal. Максимальный сухой вес райграсса был получен тогда, когда растение достигло максимального кущения, исключение составил сорт Westerwolds.

ИССЛЕДОВАНИЯ СЕМЕННОЙ ОБОЛОЧКИ И ПРОРАСТАНИЯ СЕМЯН РАСТЕНИЙ ПУСТЫНИ

1. Структура семенной оболочки у некоторых *Asclepiadaceae*

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Автор связал структуру зрелых семян 4 видов семейства *Asclepiadaceae* с их поведением во время проростания. Семена у ***Leptadenia pyrotechnica*** имели самую слабую по структуре, семенную оболочку, и следующими за ними оказались семена ***Calotropis procera***. Семена ***Pergularia daemia*** имеют утолщенные волоски, которые вызывают некоторую задержку в поглощении воды. Семена ***Cryptostegia grandiflora*** не имели какую-либо сложную структуру, но прорастание совершалось успешнее в полной темноте. Ни у одного из этих видов не было периода покоя у семян с твердой семенной оболочкой.

ВЛИЯНИЕ ВЛАЖНОСТИ ПОЧВЫ НА НЕСИМБИОТИЧЕСКУЮ ФИКСАЦИЮ АЗОТА

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Оптимальный уровень влажности для роста и быстрого размножения азотобактера на суглинистой почве оказался равным 50—75 процентам водоудерживающей способности почвы. Общее число увеличивалось с увеличением влажности и максимальное количество их было получено при 100-процентной водоудерживающей способности почвы.

Количество общего азота заметно увеличивалось при 25, 50 и 75 процентах водоудерживающей способности почвы. С другой стороны, обнаружена заметная потеря азота при 100-процентной водоудерживающей способности почвы. Тем не менее, максимальный прирост азота был обнаружен при 50-процентной водоудерживающей способности и этот факт находился в соответствии с максимальной скоростью разложения органического вещества.

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CONTRIBUTION TO THE ANATOMY OF CAPSICUM ANNUUM L.

III. COMPARATIVE STUDY OF THE ENDOCARP

By

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The endocarp of the fruit wall was examined in various red pepper and food-paprika varieties. There are two kinds of endocarp cells. There are sclereids among the thin-walled parenchyma cells. The pitted thick-walled sclereids form cell groups in the endocarp. Sclereids on veins can mostly be found scattered, in small groups. The average size and shape of sclereids and sclereid groups found in the most important red pepper and food-paprika varieties were determined.

Introduction

The anatomical knowledge of the endocarp (inner epidermis of the fruit wall) of paprika is still highly insufficient. Its general description can be found in works by AUGUSTIN (1907), GASSNER (1955), HAZSLINSZKY—TAKÁCS (1960), OBERMAYER—MÁNDY—BENEDEK (1955), SOMOS (1966), etc. In these works only a short description of the endocarp is given, and differences between paprika varieties are not discussed.

MODOR (1946) was the first to make a more thorough comparative study on the fruit-wall (pericarp) of paprika. His aim was to differentiate milled red pepper and food-paprika varieties by microscopic examination. He found differences between the varieties in the development of endocarp sclereids and the shape and size of cell groups. Sclereid groups were found to be longitudinally elongated in the food-paprika and red pepper varieties, while circular or elliptical in the pimiento and cherry-pepper. However, no closer data were presented on his investigation results.

In our papers published recently (KONECSNI 1959, 1964) differences of sclereids in the endocarp of paprika varieties were also mentioned. One of the most recent studies is a paper by PLAVSIC-GOJKOVIC (1960) in which the author presents a very precise description of the fruit-wall of various Yugoslavian red pepper and food-paprika varieties, and the measurement results of cells in certain tissues. GÖRGÉNYI (1965) carried out detailed evolutionary studies on the pericarp tissues of food-paprika varieties.

Material and Method

The paprika fruits examined originated from the following institutions: *a)* National Institute of Agricultural Variety Trials, Szeged and Budatétény; *b)* Institute of Agrobotany, Tápiószele; *c)* Agricultural Experimental Institute of Délalföld, Red Pepper Breeding and Production Group, Szeged; *d)* Agricultural Experimental Institute of Duna—Tisza köz, Red Pepper Breeding and Production Department, Kalocsa.

Material when collected was fixed and preserved in 50 per cent alcohol. From the preserved material sections and skinned preparations were made with hand technique. Microscopic preparations were preserved partly unstained in glycerine gelatine, partly stained with malachite green and embedded in water soluble synthetic resin (polyvinyl alcohol) (SPURR 1954). The malachite green caused an intensive colouration of the lignified parts (SÁRKÁNY—SZALAI 1964), so the latter could be easily differentiated from the unstainable cellulose-walled parenchyma cells.

For microscopic examination hand-made preparations of the inner epidermis and vein epidermis of fruit-walls of 9 red pepper, 15 food-paprika, 3 cherry-pepper and 3 so-called chilli-pepper varieties were used.

The photos made of the skinned preparations are differently magnified. The photos of the sclereid groups are magnified to a lower (80×) while those of the shape of sclereids to a higher extent (190×).

Taxonomic determination of paprika varieties was carried out on the basis of works by MÁNDY (1946) and TERPÓ (1965).

Results

The inner epidermis (endocarp) of the paprika fruit-wall consists of a one cell layer with two types of cells. The basic tissue is built of thin parenchyma cells with slightly undulating walls in most cases. These cells are either longitudinally somewhat elongated, or isodiametrical. The material of the cell-wall is cellulose. Minor differences between the varieties cannot be determined in milled paprika samples. Namely, cells withered during the process of drying are completely destroyed by milling.

The parenchyma epidermis cells adjacent to the giant cells are replaced by sclereids considerably thickened at the radial side. The giant cells are cells of conspicuously increased size below the inner epidermis. Their length may be as much as 2—4 mm, and width 0.6—0.8 mm. One side of the giant cells is in direct contact with the inner epidermis (FRIDVALSZKY—NAGY 1966). Walls of surface epidermis cells adjacent to the giant cells are thickened and lignified. Material transport between the lignified cells on the one hand, and between lignified cells and giant cells on the other, takes place through tiny pits. From a top-view these pits can be seen on the tangential walls of cells as tiny dark spots. On the considerably thickened and lignified radial walls thickening is frequently broken by the pits. Owing to the pits standing oppositely the cell-wall looks like a string of beads.

In most paprika varieties the lignified sclereids form long stretched cell groups on the fruit wall. The shape and size of cell groups depend on the giant cells below them and may be characteristic of the variety group.

On the dividing walls ("veins") developed along the interlacing of carpels, lignified cells are also to be found. However, on veins they do not develop in regular groups, but in long strips, scattered in smaller or larger irregular loose groups or one by one. Towards the edges of veins the number of sclereids gradually decreases, and in certain varieties (e.g. kalinkói) at the edges the sclereids are completely missing. Similarly, on the veins of cherry-peppers hardly any sclereids can be found.

The shape of the epidermis sclereids of veins is generally similar to those in the fruit-wall. They are mostly elongated (Fig. 11), but very often almost isodiametrical irregularly angular sclereids and sclereid groups can also be found (Fig. 12).

Shape, thickening and extent of lignification of endocarp sclereids are characteristic of the variety or variety group.

Diagnostic characters and other features of the various variety groups are presented subsequently on the basis of our investigations and measurements.

I.

Capsicum annuum (L.) convar. *longum* (DC.) provar. *rectum* Fingerh. — red peppers

Varieties examined: E 15, Sz 47—25, Sz 47—137, Sz 48—163, Dokomlási 2710, Várszegi, F 03, K 567, Sz 54—6.

On the inner fruit-wall of red peppers the sclereids form mostly regular, long-stretched, spear-shaped groups. The edges of the sclereid groups can be clearly distinguished from the adjacent parenchyma cells. They are rather close spaced (Figs 1, 2, 3). The group sizes of the most important varieties averaged from 20 measurements each, are shown in Table 1.

Sclereids are elongated, mostly of irregular brick-shape with slightly undulating thick cell-walls (Figs 7, 9). With 600× magnification we counted the cells in 10—20 visual fields. Namely, sclereids are of very different size, so measuring them one by one gives — even in case of a series of measurements — highly subjective results. Therefore we considered it more adequate to count, and calculate respectively, the number of cells found in 1 mm^2. Average numbers thus obtained in some varieties are presented in Table 1.

II.

Capsicum annuum (L.) convar. *longum* (DC.) — food paprika varieties with oblong fruits.

Varieties examined: Hatvani, Elefántormány, Kosszarvú, Szerecsenpaprika, Sárgapaprika.

Sclereid groups are long, narrow, spear-shaped. In certain varieties the edges of groups are indistinct or broken. In the variety Elefántormány the sclereid groups are sometimes adjoining. In other varieties (e.g. Kosszarvú)

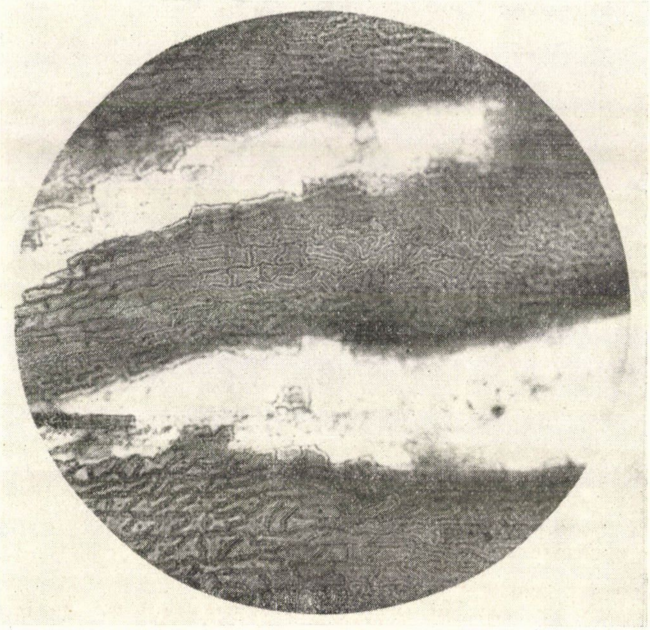

Fig. 1. Endocarp of the red pepper variety Kalocsai E 15. 80×

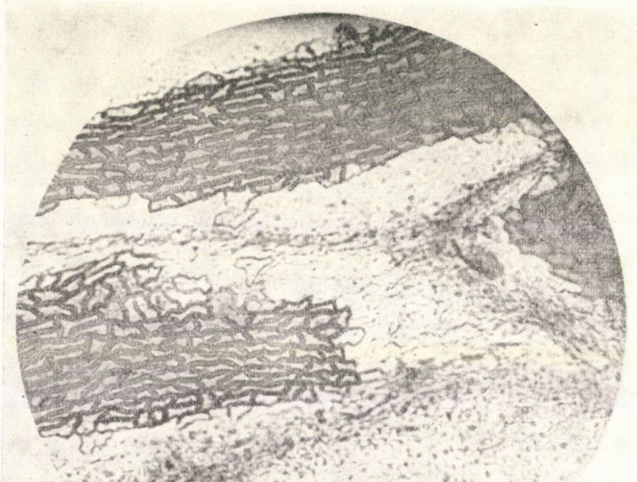

Fig. 2. Endocarp of the non-hot red pepper variety Szegedi 47—25. 80×

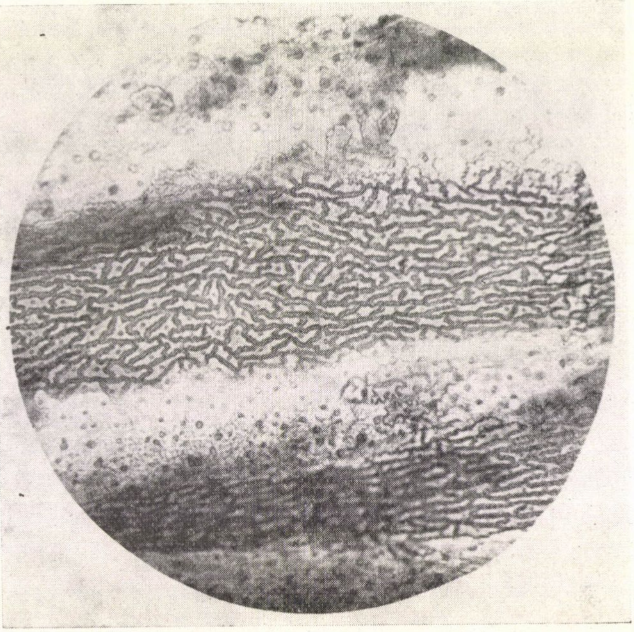

Fig. 3. Endocarp of the hot red pepper variety Szegedi F 03. 80×

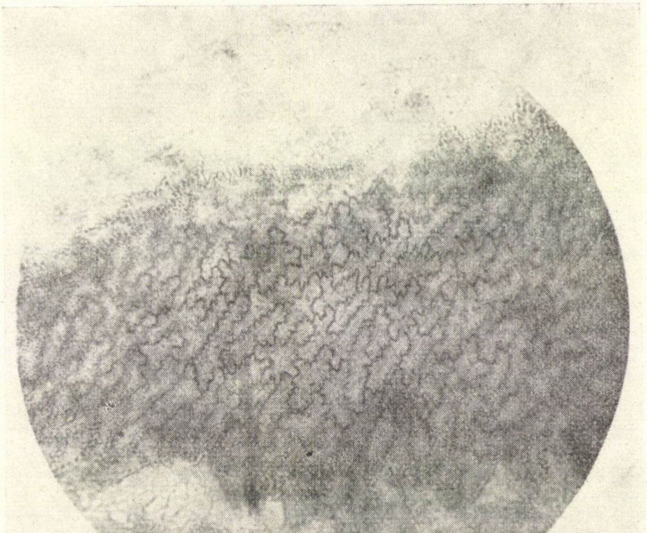

Fig. 4. Endocarp of the paprika variety Cecei édes 3. 80×

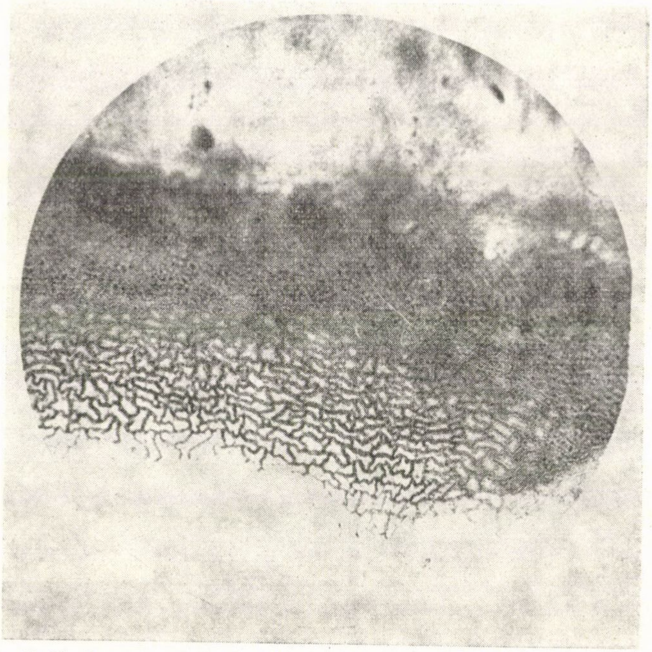

Fig. 5. Endocarp of the food paprika variety Kalinkói zöld. 80×

Fig. 6. Endocarp of the Sárga lecsüngő "Chilli" paprika. 80×

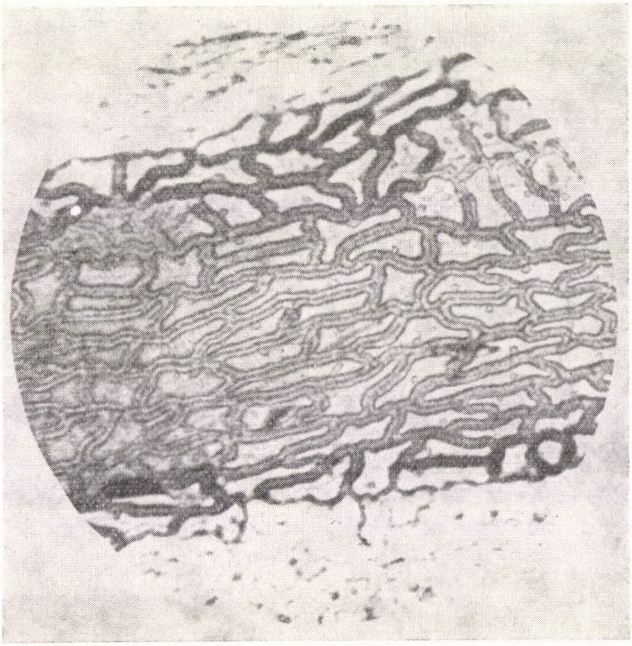

Fig. 7. Sclereids in the hot red pepper variety Szegedi F 03. 190×

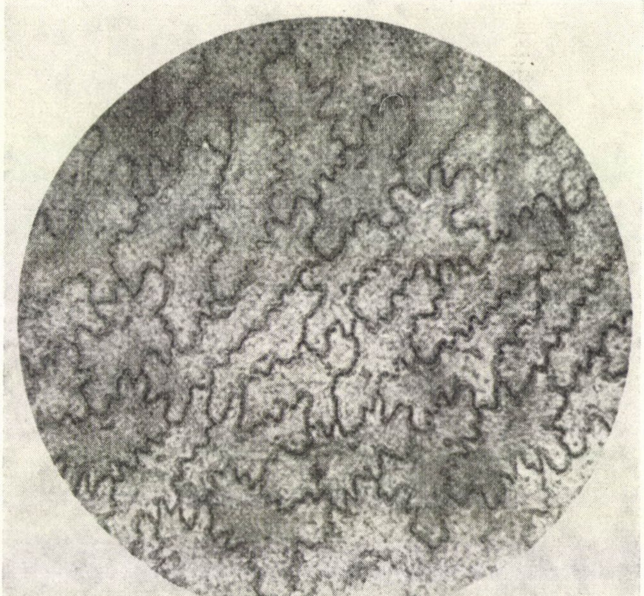

Fig. 8. Sclereids in the food paprika variety Cecei édes 3. 190×

Table 1

Measurements of sclereid groups and numbers of sclereids in various paprika varieties

Variety group	Variety	Sclereid groups		Number of sclereids	
		length mm	width mm	per mm²	average
I.	E 15	2.86	0.33	590	609
	Sz 47–25	2.95	0.31	609	
	Sz 48–163	3.03	0.30	627	
II.	Hatvani	3.45	0.30	682	604
	Elefántormány	3.75	0.25	437	
	Kosszarvú	3.43	0.20	694	
III.	Cecei édes	4.10	0.44	433	570
	Tokodi édes	3.00	0.31	572	
	Bogyoszlói	3.67	0.44	716	
IV.	Kalinkói zöld	2.25	0.45	454	526
	Új édes mammut	2.32	0.52	610	
	Szentesi	2.41	0.48	513	
V.	Paradicsom alakú zöld	1.90	0.56	590	505
	Paradicsom alakú fehér	1.84	0.56	410	
	Narancssárga paradicsom	1.80	0.53	515	
VI.	Szegedi apró cseresznye	0.68	0.37	460	491
	Szegedi nagy cseresznye	0.73	0.39	490	
	Tétényi apró cseresznye	0.80	0.41	522	
VII.	Sárga "Chilli"	2.39	0.18	496	525
	Kínai "Chilli"	2.12	0.16	560	
	Japán Hontaka	1.95	0.15	520	

they are scattered. Cells are mostly elongated with undulating cell-walls (Kosszarvú, Elefántormány) or less undulating ones (Szerecsenpaprika).

III.

Capsicum annuum (L.) convar. *grossum* (L.) Terpo - food paprika varieties with conic fruits.

Varieties examined: Cecei édes 3, Tokodi édes, Bogyiszlói.

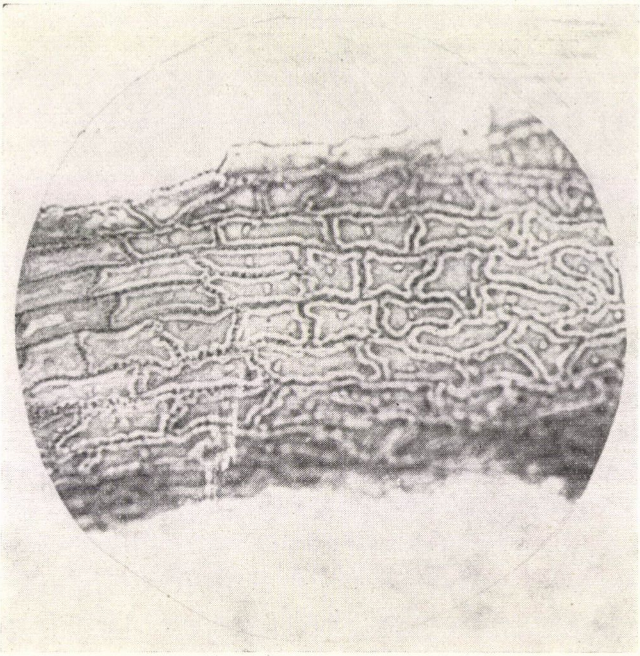

Fig. 9. Sclereids in the red pepper variety Kalocsai E 15. 190×

Fig. 10. Sclereids in the cherry-pepper variety Tétényi apró cseresznye. 190×

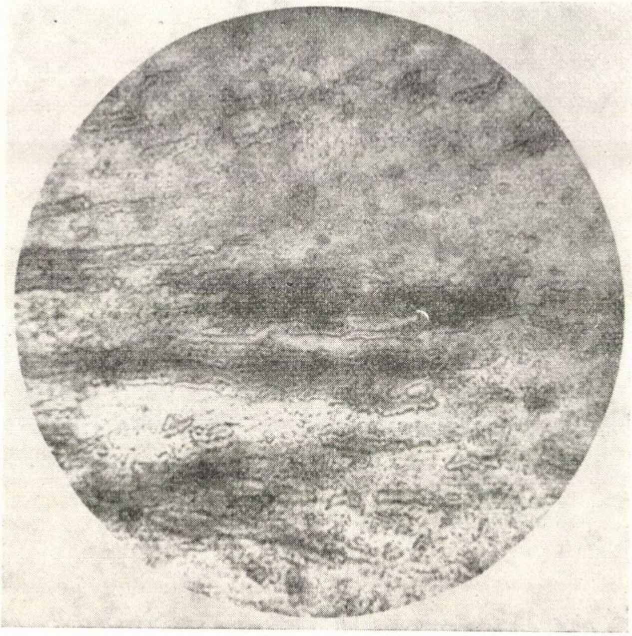

Fig. 11. Sclereids in the veins of the red pepper variety Kalocsai E 15. 80×

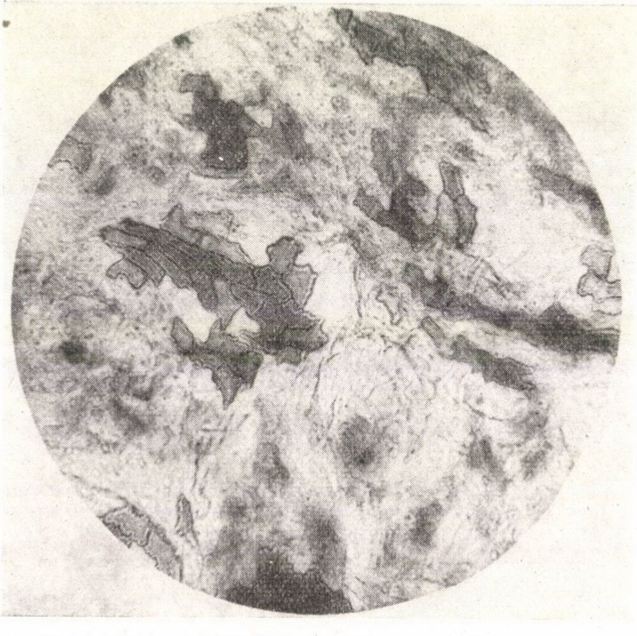

Fig. 12. Sclereids in the veins of the red pepper variety Kalocsai E 15. 80×

Sclereid groups are elongated, with irregular, indistinct (Cecei édes 3) or sharp (Bogyiszlói) edges. Cell groups are sometimes densely spaced, sometimes rather scattered.

In the variety Cecei édes 3 there are two types of sclereids: one of them is hardly elongated, large with a very undulating cell-wall (Fig. 8) the other is straight, elongated with rather thick cell-wall.

IV.

Capsicum annuum (L.) convar. *grossum* (L.) Terpo provar. *grossum* (L.) Sendt — food paprika varieties with cylindrical fruits.

Varieties examined: Kalinkói zöld, Új édes mammut, Szentesi, Kaliforniai Wonder.

Sclereid groups are broad and shorter than those in the long berried paprika varieties. The edges of sclereid groups are sometimes indistinct, sometimes sharp (Fig. 5). In some places many smaller sclereid groups and irregularly scattered sclereids can be found.

The sclereids are somewhat elongated, their thick cell-walls are in most cases slightly lignified. Cell-walls are twisting, sometimes foiled and interlaced.

V.

Capsicum annuum (L.) convar. *grossum* (L.) Terpo provar. *tetragonum* Miller — food paprika varieties with tomato-shaped fruits.

Varieties examined: Paradicsomalakú zöld, Paradicsomalakú fehér, Narancssárga paradicsompaprika.

Sclereid groups are well-developed, short and broad, sometimes almost egg-shaped. The groups are close spaced. Edges are sometimes indistinct, sometimes stand out in sharp contrast to the parenchyma cells.

Sclereids are mostly isodiametrical, irregular, somewhat elongated. Cell-walls are highly undulating, at some places foiled. Thickening, and especially lignification are of low extent.

VI.

Capsicum annuum (L.) convar. *annuum* (L.) provar. *cerasiforme* (Mill.) Irish — cherry-peppers.

Varieties examined: Szegedi apró, Szegedi nagy, Tétényi apró.

Sclereid groups are small, oval or irregular shaped, sometimes close spaced. Edges are winding, lobular or broken (Fig. 10).

The shape of the sclereids is highly varied, winding, lobular. Cell-walls are considerably thickened and lignified. Owing to the twisted, lobular cell-wall the cave of the sclereid is very narrow.

VII.

Capsicum annuum (L.) convar. *longum* (DC.) provar. *acuminatum* Fingerh — exotic "Chilli" peppers.

Varieties examined: Sárga chilli, Kinai chilli, Japán Hontaka.

Sclereid groups are very densely spaced. Their shape is oblong, narrow, almost threadlike. Edges stand out sharply (Fig. 6).

Sclereids are elongated with undulating or straight cell-walls.

Table 2

Mean values of sclereid group measurements, deviation from the mean and significant differences in various paprika variety groups

Variety group	Sclereid groups			
	average		deviation from the mean	
	length mm	width mm	length mm	width mm
I.	2.95	0.31	0.08	0.02
II.	3.54	0.25	0.18	0.05
III.	3.59	0.40	0.55	0.07
IV.	2.33	0.48	0.18	0.04
V.	1.85	0.55	0.05	0.02
VI.	0.74	0.39	0.06	0.02
VII.	2.15	0.16	0.22	0.02
s.d. 5%	0.45	0.07		

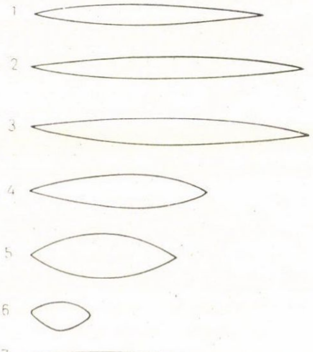

Fig. 13. Average sizes of the largest endocarpic sclereid groups of paprika variety groups as magnified 10×. 1. Red peppers; 2. Food paprikas with oblong fruits; 3. Food paprikas with conical fruits; 4. Food paprikas with cylindrical fruits; 5. Tomato-shaped food paprikas; 6. Cherry-peppers; 7. "Chilli" peppers

We performed at least 20 sclereid group measurements and sclereid countings each in endocarp preparations of 21 of the 30 paprika varieties. The mean values of the measurements are contained in Table 1. The mean values of the sclereid groups in the different variety groups as well as deviations from the mean and significant differences are given in Table 2. The average size of the most developed sclereid groups in the different variety groups is seen in Fig. 13.

Data of tables and figures prove that sclereids and sclereid groups in the fruit-wall endocarp of different paprika variety groups are characteristically differing from one another. On the basis of the shape and thickening of sclereids a paprika variety can be determined even in milled samples.

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CHEMICAL WEED CONTROL OF SORGHUM VARIETIES IN HUNGARY FROM 1955 TO 1970

By

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This paper summarizes the results and experiences obtained from 1955 to 1970 in the chemical weed control of Sorghum varieties (*Sorghum vulgare* var. *frumentaceum, Sorghum vulgare* var. *saccharatum, Sorghum vulgare* var. *sudanense*). Experiments performed so far, and experiences gained in farms, show that in well preserved soils of non-extreme type Atrazin and Ramrod are the most suitable for the weed control of grain sorghum varieties. Under Hungarian conditions the optimum dose is 4 + 4 kg/ha. With sweet sorghum too, Atrazin has been applied with good results (5 kg/ha). When spraying stands 2.4 D can be used in a dose of 1.75 kg/ha for the weed control of Sudan grass.

Introduction

In the last two decades extensive herbicide research has been carried on all over the world at a rapid rate, and this work has already yielded important results. It is only natural that research work has started with Sorghum species too, as they are extremely sensitive to weeds. During the last ten years a considerable progress has also been shown in this respect in the published data of world literature and in exchanges of experiences. This fact is proved also by Hungarian experiences. According to the data of foreign literature — (Albert 1961, Alkämper 1962, Burnside *et al.* 1964, Chesalin *et al.* 1962, Hugues 1963, Knacke *et al.* 1965, Phillips *et al.* 1964, Sarpe *et al.* 1967, Solov'ev 1956, Stickler 1964, Storchevoy 1959, Robinson *et al.* 1960, Wiese *et al.* 1959, Vitrac 1961) — and the results of investigations carried out in Hungary (Kükedi 1962, 1965, Somogyvári 1964, Szigethy 1964, Tóth 1964) Atrazin and Propazin of the triazine derivatives as well as 2.4-D seem to be suitable for the weed control of Sorghum species. Ubrizsy (1969) remarks, however, that the latter causes pathological lesions when it gets into animal organisms. In some fields problems which are expected to cause serious difficulties in the future were raised in the last decade, of which the most important ones can be summarized as follows:

1. Owing to a regular application of herbicides with a triazine base some monocotyledonous weed species, such as *Setaria glauca*, *Setaria viridis* as well as *Echinochloa crus-galli* have overgrown certain areas. 2. Among the dicotyledonous weeds the spreading and control of *Convolvulus arvensis*, *Cirsium arvense*, *Rubus caesius*, *Lepidum draba* etc. give more and more trouble. 3. Due to the extreme weather conditions and frequent droughts

in Hungary, weed control is much less effective than in countries with more favourable, well distributed precipitation. 4. Considerable differences depending on the types of soil are also found. In heavy soils the weed killing effect required can be attained only by increasing the doses of triazine based herbicides, but in this case the danger of causing injuries to Sorghum increases as well. On drift-sands and light sandy soils, in the case of pre-emergent application, wind erosion and a possible resulting failure of chemical weed control must be reckoned with. Weed killing effect is similarly uncertain on meadow clay soils and alkaline areas. 5. As to herbicide sensitivity, there are differences between species, and even between varieties. 6. Some of the chloro-amino-triazine based herbicides have after effects for several years, which makes it difficult to choose the right succession of plants. 7. It is not only chlorinated hydrocarbons used earlier for soil disinfection, but also certain herbicides that cause damage to health. For example, according to examinations performed in Hungary 2.4-D caused lesions of the liver, loss of weight and decreased the iodine binding ability of the thyroid gland in the experimental animals. Some of the questions raised made it necessary to continue the examinations started in 1955.

Material and Method

Examinations were carried on between 1955 and 1970 at the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár on the chernoziem soil of a former forest. Most of the experiments were laid out in a random block design in four replications, mostly in plots of 10—20 m². Farm experiences were gained, on the other hand, from every part of the country. During the past 15 years mainly herbicides of the firm Geigy (Atrazin, Propazin, Simazin, Ametrin, Prometrin, A 1403, A 1798, A 1802, A 3620, Igran etc.) as well as the Hungarian made Hungazin PK (Atrazin) and Hungazin DT (Simazin) were examined in the experiments, but, in addition, the following herbicides were also tested: Afalon, Aresin, Karmex, Lasso, Randox, Ramrod, 2.4-D and A 2918. Doses ranged between very wide limits (1—15 kg/ha). Spraying was carried out in the autumn, in spring after soil preparation, immediately after sowing and post-emergently (the latter in an 8—15 cm high plant stand). Detailed studies were only performed, however, with the supposedly perspective herbicides, while those which proved to be wrong with regard to weed killing effect, or caused any injury, were at once excluded from the experiments. So it was eventually with Atrazin and 2.4-D that the majority of the experiments was carried out.

Among grain sorghum varieties mainly the American NK 120 and NK 125 were examined, but in addition to these Early Hegari as well as some non-certificated hybrids produced in Hungary were also included in a number of experiments. Among sweet sorghum varieties Early Sumac and Sumac were used in the experiments.

Among Sudan grass varieties the common Sudan grass, the sweet Sudan grass and the first Hungarian hybrid Sudan grass (Hybar Mv 301) were examined.

Considering that meteorological conditions have a great influence on the results of experiments, it is necessary to mention the most important of these (average of 40 years). Accordingly, temperature values in the 12 months of the year were as follows:

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
—1.9	—0.3	5.2	10.1	15.9	19.1	21.5	20.7	15.7

X.	XI.	XII.	
10.6	4.6	0.2	°C

while the amounts of precipitation were:

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Mean
31	31	39	46	66	62	50	52	52	53	46	43	571 mm

In connection with the precipitation data it should be noted that though the amounts would be satisfactory from the point of view of efficient weed control, the often unfavourable distribution — spring droughts — makes supplementary hoeing indispensable.

Results

Results and experiences gained in experiments performed with 2.4-D (dichloro-phenosy-acetic acid), one of the best known hormone-based herbicides, are dealt with first. In his paper published in 1965 the author has already written about the serious injuries caused to the roots of Sumac by 2.4-D. Recent examinations have shown similar injuries both in grain sorghum and Sudan grass varieties (Figs 1, 2). In addition, both when sprayed after soil preparation in spring and in case of a pre-emergent application 2.4-D was found to cause a decrease in plant number in the grain sorghum stand (1968). The percentage compared with the hoed control (100 plants) was 46.07% with a dose of 2 kg/ha, while it was only 38. 67% with 4 kg/ha. In the latter treatment 61% of the plants were killed. On areas sprayed after soil preparation in spring, percentage values were 51.68 and 29.86% respectively with the same doses. Consequently, under rainy conditions 2.4-D applied at the mentioned times causes serious damages. On the other hand, in dry weather no damage is done, and the lodging of the plants, which very often occurs when roots are affected does not have to be reckoned with.

Post-emergent spraying did not cause losses either in grain sorghum, or sweet sorghum, or even in the Sudan grass varieties. Its precondition is to wait until the plants reach a height of 10—15 cm and the roots are not located in the upper 4—5 cm soil layer but penetrate deeper than herbicide level. In hot weather (above 25 °C), however, rolling and deformation may occur in leaves, but if the weather is not extreme the plants recover in 8—10 days. In spite of all this, according to experiences gained so far, 2.4-D can be used in the weed control of Sudan grass varieties. The necessary dose is 1.75 kg/ha, and spraying should be carried out at a time when plants are 10—15 cm high. In this way Sudan grass varieties are helped through the period when they are apt to become overgrown with weeds, while later, after 4—6 weeks, they do not need any care. Namely, some 4—6 weeks after sowing Sudan grasses are highly suitable for suppressing weeds. In well preserved soils sowing after maize treated with Atrazin in the previous year may be successful, provided it is not monocotyledonious weeds which are the dominating species. Nevertheless, the main points should be — if it is possible at all — to sow in a well preserved soil and to prepare the soil with the greatest care in order

Fig. 1. Left: injured sweet Sudan grass roots treated with 1.75 kg/ha 2.4-D; right: untreated ones. Spraying: May 29. 1966. Exposure: July 18

Fig. 2. Left: grain sorghum roots damaged by 1.75 kg/ha 2.4-D; right: untreated ones. Spraying: May 29. 1966. Exposure: July 18. 1966

Fig. 3. Left: Sweet Sudan grass treated with 1.74 kg/ha 2.4-D; right: control. Spraying: June 16. 1958. Exposure: June 20. 1958

to ensure weed-free conditions. Herbicides should be applied only when the future of the Sudan grass stand is endangered by weeds (Fig. 3).

The best method is, however, not to grow sorghums on areas overgrown with weeds.

Plant protection in grain and sweet sorghum stands cannot be confined to applications of 2.4-D, as under Hungarian conditions the effect of Dikonirt lasts only for 4—6 weeks. If this herbicide is used, the necessity of hoeing should be taken into account. The fact that 2.4-D has no effect on monocotyledonous weeds should also be taken into consideration.

Atrazin is the herbicide which has so far been used the most extensively and reliably for chemical weed control in grain sorghum and sweet sorghum. With the exception of extreme weather conditions and certain soil types (alkaline soil, heavy meadow clay, drift sand) its weed killing effect is always satisfactory, and — when used in the right dose and at the right time — it does not cause damage. Under the given conditions yields were mostly equal to those of the hoed control. It has a satisfactory weed killing effect on dicotyledonous weeds, and, when used in a dose of 8 kg/ha, is effective against monocotyledonous weeds as well. Owing to the herbicide sensitivity of sorghums this dose cannot, however, be used. Such a dose is disadvantageous if only because of its increased after-effect. Under the given conditions, on a cher-

Fig. 4. 5 kg/ha pre-emergent Atrazin treatment of grain sorghum. Exposure: June 27. 1969

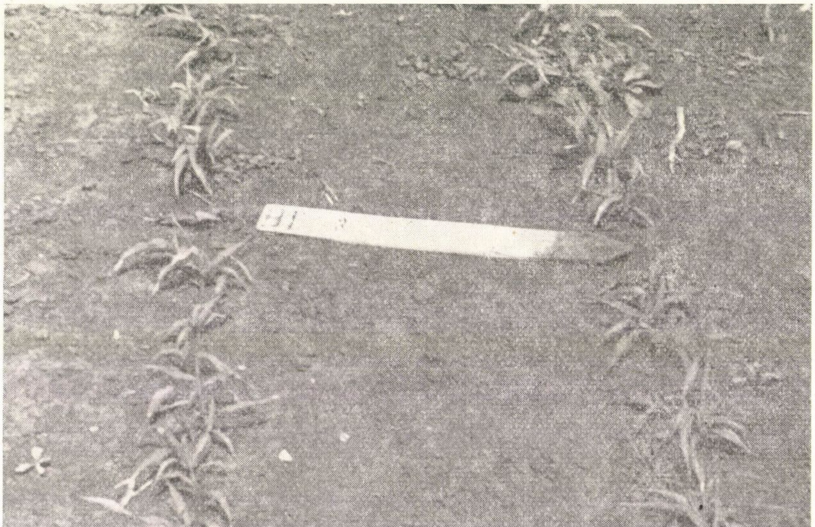

Fig. 5. 4 kg/ha pre-emergent Atrazin treatment of grain sorghum. Exposure: June 6. 1966

noziem-type soil 4—5 kg/ha is the dose that has not caused any damage so far. There were droughty springs, when even a 15 kg/ha dose did not cause any decrease in the number of plants, but in such cases the weed killing effect was unsatisfactory and the plants even had to be hoed.

As to the time of spraying, favourable results were obtained with spraying in the autumn (5—6 kg/ha). In this case, however, doses of 3—4 kg/ha proved to be too small. Spraying carried out in spring after soil preparation, immediately before sowing gave extremely good results in 1969. True, in that year the distribution of precipitation was very favourable and the growing area was well preserved. In these treatments as well as in the case of a pre-emergent application plots were almost completely weedless (Fig. 4). A similarly good result was obtained in 1966 (Fig. 5). According to observations made so far the most careful possible soil preparation followed by an adequate amount of favourably distributed precipitation are the basic conditions for successful weed control. Otherwise a supplementary hoeing is indispensable.

A further difficulty involved in using Atrazin for weed control — especially in the case of a pre-emergent application — is that seeds sown at a depth of 2—3 cm only may be damaged. This occurs mainly in sandy soils, but may occur in lighter chernoziem soils of a relatively loose structure as well, if in the period after sowing 15—20 cm or more rain falls in one day. On the other hand, when the roots have already passed through the upper layer where herbicides are found, no damage is ever done. Experiences show that the extent of destruction has never exceeded 10—15%.

In the case of pre-emergent application reduction in the number of plants need not be reckoned with. Here the only difficulty is caused by the fact that by the time sorghums reach a height of 10 cm — especially in cold springs — weeds too become strong and resistant and can only partly be destroyed with an Atrazin dose of 4 kg/ha. No doubt, in sandy soils where the danger of destruction is considerable, this mode of application may be successful. When spraying stands, not more than 3 kg/ha should be used.

In sorghum stands free of weeds the time of spraying also has great importance. A good example is the year 1969, when in the post-emergent treatments nearly all plots were entirely weedless. Against monocotyledonous weeds, however, Atrazin gives no adequate protection even when applied in a dose of 4—5 kg/ha.

On such areas only combined chemicals (Ramrod) or a supplementary hoeing can help. The economy of the latter is, however, highly questionable. In the case of a labour shortage the combination of Atrazin + Ramrod can thus be used with advantage (4 + 4 kg/ha in spring, after the soil preparation). In certain cases, with a plant height of 10—15 cm the combination of Atrazin (3 kg/ha) + 2.4-D (1.5 kg/ha) may offer some help. Experiences gained in the last few years showed that chemical weed control in sorghum was not always successful with Atrazin applied by itself.

Results obtained by using the Hungarian-produced Hungazin PK (Hungarian Atrazin) correspond to those described with Atrazin, so it will not be separately discussed here.

Sorghums are much more sensitive to Simazin and the similar Hungazin DT than to Atrazin, therefore after 2 years they were not tested further.

Sorghums are seldom tolerant to 4 kg/ha doses of Ametrin and Prometrin, and are highly sensitive even to their combinations, although the weed killing effect of these chemicals is very good. Considering that these herbicides too caused damages and losses in the experimental years they were not tested any longer.

The Geigy herbicides: Propazin, A 1403, A 1798, A 2099 exerted a satisfactory weed killing effect, but did not surpass the effect of Atrazin. They sometimes slowed down the growth of grain sorghum varieties for 8—10 days, therefore these herbicides were excluded from the experiments.

On the other hand, the herbicide A 3620 sent last year for testing seemed to be promising in the 1969 experiments. Its final evaluation, however, requires further investigations.

Igran did not come up to expectations. Its weed killing effect was much weaker than that of the Atrazin, and in the case of post-emergent application it retarded the growth of grain sorghum for 8—10 days. However, it never destroyed the plants. This herbicide will not have any special importance in the weed control or sorghums.

Among herbicides other than Geigy's, Ramrod appears to be the most promising. Since it is highly effective against some monocotyledonous weeds, such as *Setaria species* and *Echinochla crus-galli* its being added to other chemicals is expected to be advantageous. When used with Atrazin the recommended dose is 4 kg/ha of each applied in spring after soil preparation, immediately before sowing.

Lasso applied to grain sorghum gave fairly good results in 1968, while in 1969 Ramrod was superior. Thus, it is on the latter combination that a detailed study is considered to be necessary.

In 1966 Aresin reduced the number of plants in grain sorghum, and beside this, did not offer adequate protection against monocotyledonous weeds; therefore it was excluded from further trials. Afalon, Randox, H 2918, Karmex did not seem suitable for weed control in sorghums either, so they too were dropped.

As for future tasks, a thorough study of herbicide combinations is suggested. In this respect Atrazin, Ramrod and — perhaps — Treflan are recommended. If the Geigy herbicide A 3620 gives results similar to those of the year 1969 in further experiments as well, it may be suitable to replace the Atrazin.

Since climatic conditions cannot be changed it may happen (in the case of extremely dry weather or exceptionally weedy soil) that hoeing or stand spraying must be reckoned with. Those described under 4 can be helped by choosing the right herbicide doses and spraying time, thus difficulties caused by differences in soil types can be partly eliminated.

Sensitivity to chemicals of the individual varieties within the *Sorghum* species will be worth studying in detail only when perfectly reliable herbicides or their combinations are available.

Considerable attention should be paid in the future to producing herbicides of one-year action so that they do not make the succession of plants difficult to determine.

Last but not least, the question of herbicides harmful to human and animal organisms should be treated with the greatest possible care, lest herbicides should be a curse rather than a blessing!

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HISTOGENETIC STUDY ON THE EXOCARP, MESOCARP AND ENDOCARP OF THE ALMOND

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In our histogenetic studies the individual layers in the fruit-wall of the almond were found not to be simply the equivalents of the different layers of the ovary-wall. The exocarp can be traced back to the outer epidermis of the ovary-wall. On the other hand, it is not the whole mesophyllum but only its outer half, the abaxial part of the ovary-wall, that the mesocarp has developed from. The endocarp is of the most complicated, double origin, having developed in part from the mesophyllum, in part from the inner epidermis.

Introduction

The fruit-wall of stone-fruits consists of three distinct layers. The outermost layer, the exocarp, is generally one-layered; it is the so-called skin. The next layer is the mesocarp which — with the exception of the almond — is the juicy flesh. The innermost layer is the endocarp, the stone proper. The layers of the fruit-wall develop from the tissues of the ovary-wall. Present paper is intended to find out which are the tissue elements — layers — of the ovary-wall, the three layers of the almond fruit-wall develop from. Author's studies are justified by the fact that no precise description of the histogenesis of the almond fruit-wall has been found in the literature.

HEGI (1919), MOELLER—GRIEBEL (1928), GASSNER (1955), SÁRKÁNY—SZALAI (1964) and KÁRPÁTI *et al.* (1968) equally call the stone endocarp; they do not refer, however, to its double origin but consider it to have developed from the inner epidermis. KÁRPÁTI *et al.* (1968) place the almond among the trymes where the outer and middle layers of the fruit-wall (exocarp and mesocarp) form the envelop that becomes detached, and the inner layer (endocarp) forms the stone. MOELLER—GRIEBEL (1928), GASSNER (1955) and HAZSLINSZKY—TAKÁCS (1960) mention the triple distribution of the stone: the outer layer of the endocarp consists of moderately elongated sclereids, the middle part contains vascular bundles, and the inner 'hard' layer is formed by rather elongated irregular sclereids. Authors do not refer to their origin. PÉNZES (1957) generally concludes on its originating from the inner part of the developing carpel and points out that it can be divided into two separate tissue-parts: an inner layer containing mostly oblong macrosclereids, and an outer part consisting mostly of isodiametrical sclereids with channel-like cell-wall thickening.

Material and Method

Author examined two almond varieties: bitter almond and the sweet almond variety Fruit's plates. From the time of flowering samples were taken of growing fruits for four months.

Of the paraffin-embedded flowers and young iruits sections were made by means of a microtome. Out of the more developed fruits hand sections were made. The sections were stained with a mixture of haematoxylin and safranin of a ratio of 3 : 1.

Results

In the flower the wall of the pistile is bordered with a one-layer epidermis covered with hairs. Under the epidermis a mesophyllum of about 50 cell-layer thick consisting of parenchymatic cells is found. The inner border is formed also by an epidermis-layer. This outer and inner epidermis is, in fact, the one-layer dermal-tissue of the abaxial and adaxial side of the carpel. In the ground-tissue surrounded by them — that is, in the mesophyllum — the vascular bundles run down in two separate circles, and that is decidedly at the edges of the abaxial and adaxial sides of the carpel. At the abaxial side the vascular bundles are smaller and so dense as almost forming a continuous tissue ring when cross-sectioned. The vascular bundles of the adaxial side are larger and are separated by the parenchymatic tissue. The position of the vascular bundles shows a certain degree of articulation in the mesophyllum (Fig, 1).

In the very young (1—2-week-old) developing fruit-wall (pericarp) the above-mentioned structure is more conspicuous inasmuch as the ground-tissue between the outer and inner epidermis — i.e. the mesophyllum — is divided into two — approximately in the middle — by some cell-layers of highly different stainability and size.

The three-week-old fruit-wall (at the beginning of May) shows the following development. At the abaxial side of the fruit-wall certain cells of the

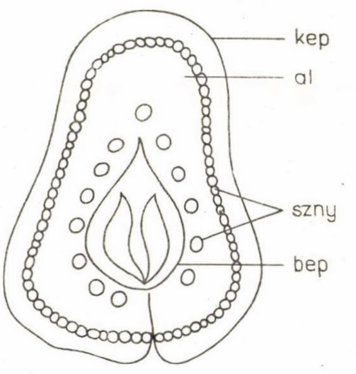

Fig. 1. Sketch of the pistile in bitter almond (kep = outer epidermis, szny = vascular bundle, al = ground-tissue, bep = inner epidermis)

epidermis grow out and form hairs. The outer epidermis is closely joined by the 2—3 cell-layer thick chlorenchyma, then by the 40 cell-row ground-tissue which consists of large, round, well stainable cells and contains innumerable vascular bundles. In the middle of the fruit-wall there is a separate, less stainable tissue-layer different from the ground-tissue, which consists of 15—18 rows of cells much smaller than those at the abaxial side of the mesophyllum. Author calls this tissue zone "dividing layer". The adaxial side of the fruit-wall contains about 30 rows of round, well stainable cells much smaller than those of the dividing layer, with small intercellular space between. The cell-walls show already the development of pitted cell-wall thickening. In the otherwise homogeneous layer the number of vascular bundles is lower than in the outer layer. This is followed by a tangentially elongated hypoderm-like layer of four—five cell-row thickness, adjacent to the inner epidermis. These cells — contrary to those of the inner epidermis — cannot be stained well (Fig. 2).

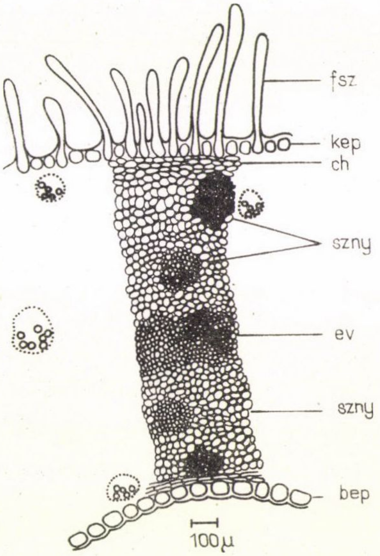

Fig. 2. Trend shown by the three-week-old fruit-wall in bitter almond (at the beginning of May). (fsz = hairs, kep = outer epidermis, ch = chlorenchyma, szny = vascular bundle, ev = dividing cell-layer, bep = inner epidermis)

The five-week-old fruit-wall (in the second half of May) shows already remarkable changes. The whole fruit-wall has significantly increased. In the mesophyllum, outward from the dividing layer, the parenchyma cells have become large, continue to be filled with plasm and have thin cell-walls. The dividing layer is only of 6—8 cell-row thick and consists of closely set tangentially elongated readily stained cells. Just beside the dividing layer, at the adaxial side of the carpel, highly stainable cell groups with pitted-like thickened walls can be found. This kind of cell-wall thickening indicates the development of the stone (Fig. 3).

In the six-week-old fruit-wall (at the end of May) the development of the stone begins not only by the side of the dividing layer but also beside the inner epidermis. The walls of tangentially elongated cells adjacent to the inner epidermis become thick and form a continuous sclerified layer.

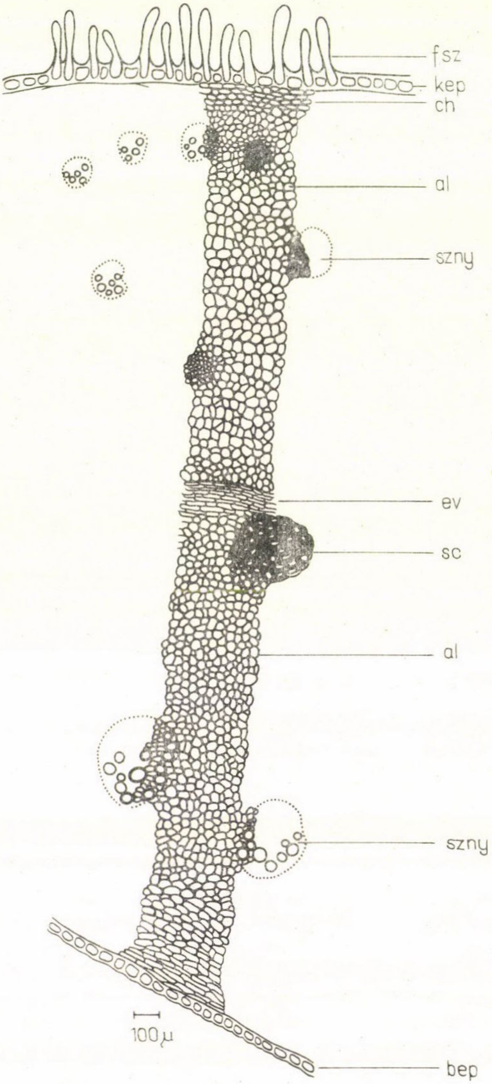

Fig. 3. **Trend shown by the five-week-old fruit-wall in bitter almond (in the second half of May). (fsz = hairs, kep = outer epidermis, ch = chlorenchyma, al = ground tissue, szny = vascular bundle, ev = dividing cell-layer, sc = sclerenchyma cells, bep = inner epidermis)**

The cells of the inner epidermis are tangentially elongated and slightly pressed, their outer walls show considerable thickening. Continuous sclerified cell groups are similarly found inward from the dividing layer, at the adaxial side. Thus in the inner part of the mesophyllum sclerification has started from two directions. However, the centre of this tissue-layer containing the vascular bundles is unchanged at that stage; the parenchyma cells surrounding the vascular bundles are still alive (Fig. 4).

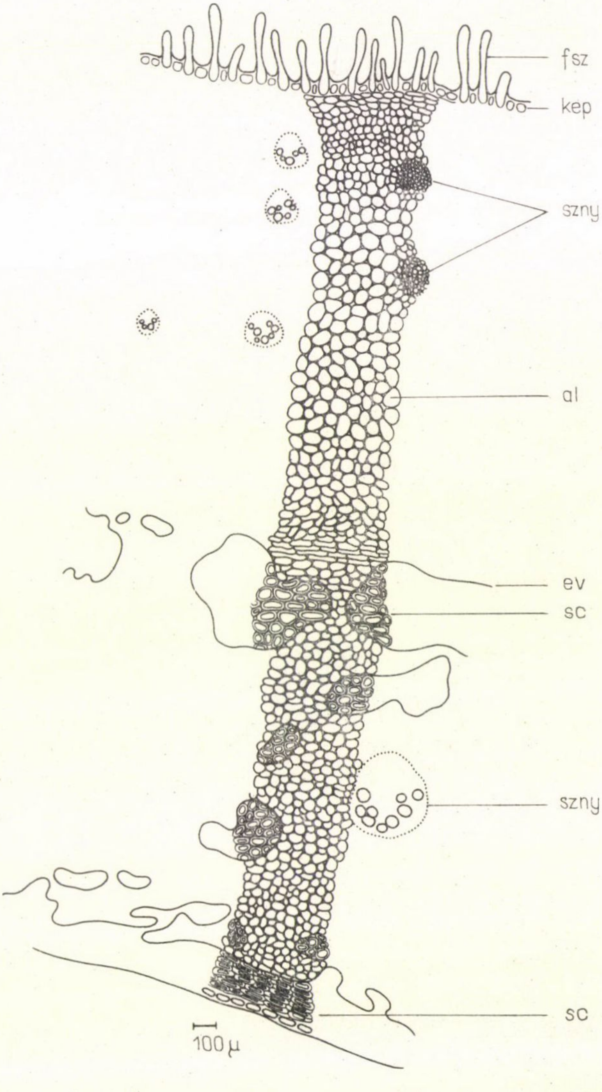

Fig. 4. **Trend** shown by the six-week-old fruit-wall in bitter almond (at the end of May). (**fsz** = **hairs, kep** = outer epidermis, szny = **vascular bundles, al** = **ground tissue, ev** = dividing cell-layer, sc = **sclerenchyma cells)**

In the seven-week-old fruit-wall (at the beginning of June) further remarkable changes can be observed. Cells in the layer dividing the mesophyllum into two parts partly die. In the inner half of the mesophyllum, in the developing stone, the sclerified tissue groups have formed a continuous tissue-layer both from the direction of the dividing layer and from that of the inner epidermis. The cell-walls gradually show a canalicular thickening. Cells in the inner epidermis have become tangentially still more pressed.

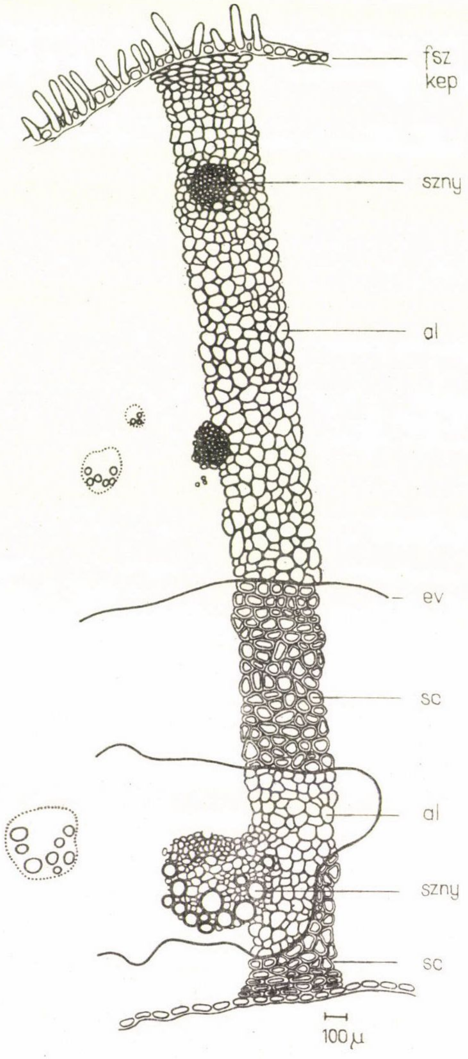

Fig. 5. Trends shown by the eight-week-old fruit-wall in bitter almond (in the middle of June). (fsz = hairs, kep = outer epidermis, szny = vascular bundles, al = ground tissue, ev = dividing cell-layer, sc = sclerenchyma)

In the eight-week-old fruit-wall (in the middle of June) the outer epidermis and the outer part of the mesophyllum (the abaxial side) are by and large unchanged. The cells are still living and readily stained. In the inner part of the mesophyllum — in the stone — as a result of the two-sided sclerification the thick-walled tissue-layers almost meet. This uniform sclerified tissue is broken by small "islands" where the vascular bundles run down surrounded by living ground-tissue cells. The transition to the sclereid cells is represented by large thin-walled cells some of which have already died, their walls are broken. The cells of the inner epidermis have tangentially been pressed to a great extent, their walls have become thick and lignified (Fig. 5).

No sections were made from the fruit-wall in further developmental phases. Nevertheless, on the basis of what have been observed so far the final development of the fruit-wall can easily be described.

Outward from the dividing layer the green husk develops. It is the cells of the dividing layer that first die and go to bits. The living cells of the green husk also die gradually, then the whole husk withers.

Sclerification of the stone continues, then terminates. Vascular bundles and ground-tissue cells around them gradually die, too. The remains of the vascular bundles can be found in the fully developed stone as functionless dry parts.

The development of the three layers of the fruit-wall was essentially the same in the bitter almond as in the Fruit's plates sweet almond, only a difference in time could be observed. Stone began to develop in the fruit-wall of the sweet almond (Fruit's plates) a week later, and arrived at the different development stages similarly about a week later, indicating a correlation with the slower development of the whole fruit (GÁL 1965).

Conclusions

As it is known, the fruit-wall of the fully developed almond has three layers: exocarp, mesocarp and endocarp. This is a three-layered ovary wall.

The author's studies have revealed, however, that the layers of the fruit-wall are not simply the equivalents of the different layers of the ovary-wall.

The exocarp originates from the outer epidermis of the ovary-wall. The mesocarp — on the other hand — does not develop from the whole mesophyllum, only from its outer half, the abaxial part of the ovary-wall. The endocarp (the stone) has the most complicated origin, a double one, being developed in part from the mesophyllum, in part from the inner epidermis. The outer half of the endocarp (stone) develops from the adaxial part of the mesophyllum. According to the author's examinations these mesophyllum cells are isodiametrical and continue to be so in the course of the sclerification as well. At the same time, the inner half of the endocarp can be traced back to the inner epidermis of the ovary-wall on one hand, and to the adjacent hypodermic layer on the other; cells of the latter become tangentially highly elongated. Results obtained from these investigations confirm Pénzes's suggestion concerning the histological development of the stone, namely its being not homogeneous but consisting of isodiametrical cells in the outer layer and longitudinally flattened sclerotic ones in the inner layer. These results correspond further to the findings of Moeller—Griebel, Gassner and Hazslinszky—Takács concerning the structure of the stone.

After all it can be stated that the dry husk of the almond — which contains the exocarp and mesocarp — develops from the abaxial part of the ovary-wall (from the outer epidermis and outer half of the mesophyllum), while the stone, i.e. the endocarp, from the adaxial part (the inner half of the mesophyllum and the inner epidermis) of the ovary-wall.

No difference in the development of the fruit-wall was found between the bitter almond and the sweet almond variety Fruit's plates, except for a shift in time, since the fruit-wall of the variety Fruit's plates began to differentiate a week later.

To sum up the above, development of the fruit-wall of almond from the ovary-wall can be outlined as follows:

$$\begin{tikzcd}
\text{outer epidermis} \arrow[r] & \text{exocarp} & \text{green opening husk} \\
\text{mesophyllum} \arrow[r] \arrow[dr] & \text{mesocarp} & \\
\text{inner epidermis} \arrow[r] & \text{endocarp} & \text{stone}
\end{tikzcd}$$

Acknowledgement

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LEAF CURLING OF PEPPER

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Pepper plants *(Capsicum frutescens* var. *grossum)* were found naturally infected. The leaves exhibited varied symptoms of mosaic mottling, blistering, malformation, and distortion, and curling upwards and the midrib zigzagged. The infected plant showed a more compact habit of growth than normal plants. The fruit of infected plant showed reduction in size and slight distortion. The virus was completely inactivated at 94 °C, had a dilution end point slightly above 10^{-6}, and was infectious for 50—55 days at room temperature (23—28 °C). Serological reactions against tobacco mosaic virus antiserum proved that the virus was tobacco mosaic virus. The virus causing leaf curling of pepper can be considered a strain of tobacco mosaic virus.

Introduction

Natural virus infection was observed on the leaves of pepper [*Capsicum frutescens* L. (*C. annuum* L.) var. *grossum*, Bailey], bell or sweet pepper, plant stout and tall; leaves oblong-ovate, 4—5 inch long, flowers 1 inch or more across; fruits large and puffy with depression at base, the sides usually furrowed, either oblong, bell-shaped or apple-shaped and tomato-like, green or red, mild in flower in a farm in the UAR during the spring months. The infected leaves exhibited varied symptoms of mosaic mottling, blistering, curling upwards and the midrib zigzagged. The fruit showed marked reduction in size.

Infection of pepper by cucumber mosaic virus, tobacco mosaic virus, tomato spotted wilt, beet curly-top virus, tobacco streak virus and alfalfa mosaic virus has been described by Doolittle—Walker (1925), Johnson (1930), Bald—Samuel (1931), Severin *et al.* (1933), Ainsworth (1933), Berkeley (1947) and Fulton (1948).

A strain of tobacco mosaic virus designated tomato atypical mosaic virus (TAMV) was proved by Miller—Thornberry (1958) to cause a new disease of tomato (tomato atypical mosaic) and of pepper (pepper atypical mosaic).

The present report of results is an attempt to indentify the virus isolated from the naturally infected pepper plants. Host range, physical and serological properties of the infectious virus were therefore studied.

Material and Method

The studies of symptoms, host range and physical properties of the virus were carried out in a greenhouse at 22—28 °C. The plants were sprayed periodicaliy with insecticides.

Transmission of the virus. For mechanical transfer of the virus, leaves of naturally infected pepper plants were collected at random. The leaves were washed and frozen for 24 hours. The juice was expressed by grinding the frozen leaves with a pestle and mortar and the sap was passed through a piece of cheesecloth. The sap was then applied by a brush to leaves of 20-day-old healthy pepper seedlings dusted with 600-mesh carborundum as recommended by RAWLINS—TOMPKINS (1936). The inoculated leaves were washed with tap water.

Host range. Different plant species were tested for their susceptibility to the unknown virus. Ten seedlings from each of 21 plant species were mechanically inoculated with infectious sap expressed from inoculated pepper plants. The following fifteen-day-old seedlings were used: *Brassica oleracea* L. var. *capitata* L. (cabbage), *Cucumis sativus* L. (cucumber), *Lactuca sativa* L. (lettuce), *Petunia hybrida* Vilm. (garden petunia), *Phaseolus vulgaris* cv Seminole and Suisse Blanc (bean), *Raphanus sativus* L. var. *aegyptiacus* Sick (radish), *Solanum tuberosum* L. (potato), *Vicia faba* L. var. *deltae* Sick. (broad bean), and *Vigna sinensis* Savi cv Black (cow pea).

About 1-month-old seedlings of *Amaranthus tricolor* L., *Chenopodium amaranticolor* Coste et Reyn, *Chenopodium murale* L., *Datura stramonium* L. (thorn apple), *Gomphrena globosa* L. (globe amaranth), *Helianthus annuus* L. (sunflower), *Ipomoea batatas* (L.) Lam., *Lycopersicon esculentum* Mill. cv Rutgers (tomato), *Nicotiana glutinosa* L., *Nicotiana rustica* L., *Nicotiana tabacum* L. cv Turkish (tobacco) and *Pelargonium zonale* L'Herit. were used.

Back inoculation to pepper plants from plants that developed mosaic mottling and from plants that did not react to inoculation was done according to RAWLINS—TOMPKINS (1936). Two leaves from each tested plant species in these 2 groups were squeezed between the fingers and the expressed sap was applied to leaves of 5 healthy pepper seedlings.

Back inoculation from necrotic local lesions on *Chenopodium amaranticolor*, *Chenopodium murale*, *Datura stramonium* and *Nicotiana glutinosa* was done by holding a leaf beneath the necrotic area which was then punched into a healthy pepper leaf with a sterile needle (JENSEN 1933, 1937). The green tissue of the leaf surrounding the necrotic area was cut, squeezed between the fingers and then applied to healthy pepper seedlings.

Physical properties of the virus. Physical properties of the virus were studied with expressed sap from pepper seedlings inoculated with the virus isolated from the naturally virus-infected pepper plants. Results obtained from this study were later confirmed using expressed sap from pepper seedlings inoculated with the necrotic areas of *Datura stramonium*. The sap was clarified by low-speed centrifugation.

a) *Thermal inactivation point.* For determination of the thermal inactivation point of the virus, expressed sap was distributed in small test tubes in 2 ml quantities. The tubes were placed in an electric water bath adjusted to give the required temperature (50—95 °C) ranging by 5-degree-step. The tubes containing the virus were kept in the water bath for 10 minutes. The meniscus of the tubes was kept 1 cm above the level of water in the bath and after the treatment period, the tubes were immediately cooled under tap water. The sap was then inoculated into healthy pepper seedlings. The above experiment was repeated with the virus kept for 10 minutes at 90—95 °C, the temperature adjusted to rise by 1 °C. The virus after being cooled quickly, was inoculated into healthy pepper seedlings.

b) *Dilution end-point.* For determination of the dilution end-point of the virus, expressed sap was serially diluted in tenfold dilutions starting from 10^{-1} to 10^{-6}. Each dilution was inoculated into healthy pepper plants. The same process was repeated with dilutions of $1:2\times10^6$, $1:3\times10^6$.

c) *Resistance to ageing.* For determination of the effect of ageing on the infectivity of the virus, expressed sap was kept at room temperature (26—31 °C). After 4—60 days, a sample of the virus was withdrawn at intervals of 5 days and inoculated into pepper seedlings.

Serological reactions. An antiserum to tobacco mosaic virus was prepared by intravenously injecting a big rabbit several times with tobacco mosaic virus from diseased tobacco plants: the antiserum was collected. Expressed sap from pepper plants inoculated with virus from natural infection, necrotic lesions and all tested plant species was heated for 10 minutes at 55 °C and centrifuged for 10 minutes at 2,000 r.p.m. A series of twofold dilutions of the clarified sap in 0.85 per cent sodium chloride solution was prepared starting from 1 : 2 up to 1 : 2048. An equal volume of tobacco mosaic virus antiserum (1 : 128 titer) diluted to 1 : 32 was then added to each tube. Control sets with sap from healthy pepper plants and antiserum and sap from diseased plants and normal serum were kept. The contents of the tubes were shaken and placed in a water-bath at 50 °C.

Results

1. *Transfer of the virus.* After about 10 days the inoculated pepper plants began to exhibit different symptoms on their new growths. The symptoms produced on the inoculated pepper seedlings were more or less the same as those naturally infected. This showed that the virus was sap-inoculable.

2. *Symptomatology.* The inoculated pepper plants produced varied symptoms (Fig. 1). Among these were leaf mottling and blistering. Within a short time, however, the leaves then curled upwards along the midrib. In most cases the midrib was zigzagged. In a few cases the midrib divided the leaf into 2 parts. In pepper plants long infected, the leaves were considerably smaller than those of healthy plants of the same age. The stem internodes were shortened considerably so that the infected plant had a more compact habit of growth than normal plants (Fig. 2). The fruits of infected pepper plants showed slight distortion and reduction in size (Fig. 3) but the colour of the fruit was not changed.

3. *Host range.* The plant species mechanically inoculated with infectious sap expressed from inoculated pepper plants reacted in 2 ways:

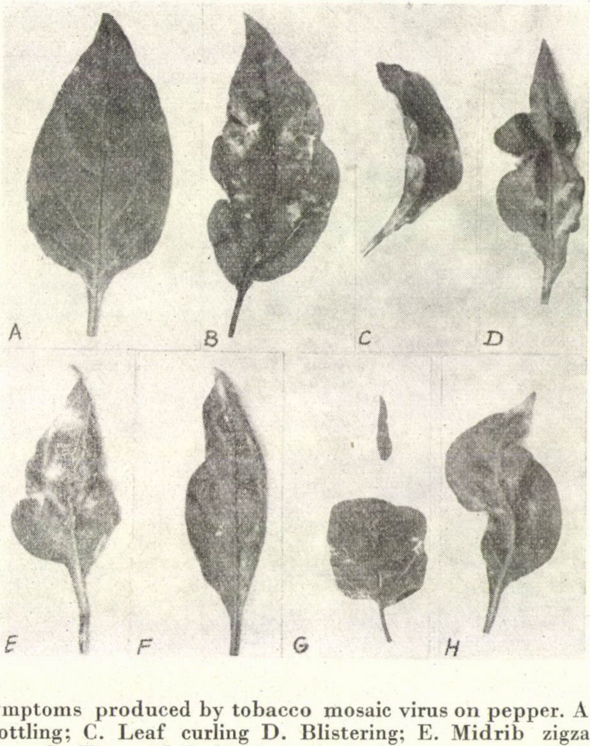

Fig. 1. Different symptoms produced by tobacco mosaic virus on pepper. A. Healthy pepper leaf; B. Mosaic mottling; C. Leaf curling D. Blistering; E. Midrib zigzagged; F. Spoon-shaped appearance; G. The midrib divided the leaf into 2 parts; H. Leaf distorted

(a) mosaic mottling or local necrotic lesions were produced on the first group, and (b) no reaction was apparent in the second group.

Nicotiana tabacum. At high temperature in summer (28—35 °C) different shades of yellow, dark green and light green appeared on the rubbed leaves

Fig 2. Left: healthy pepper plant. Right: pepper plant infected with the virus

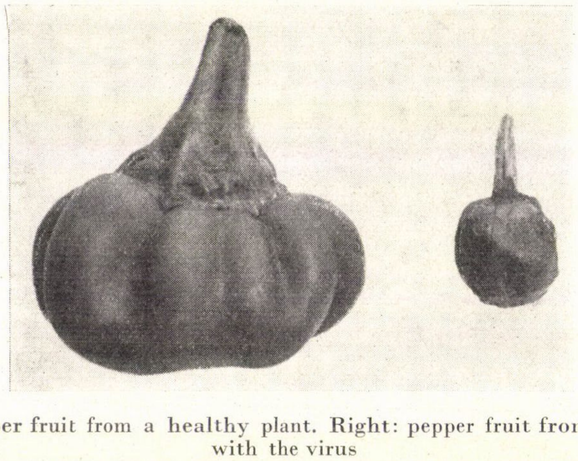

Fig. 3. Left: pepper fruit from a healthy plant. Right: pepper fruit from a plant infected with the virus

and the newly formed leaves. Banding and blistering also appeared. At low temperature in winter (18—26 °C) necrotic ringspots appeared and formed dead areas. There was no leaf distortion.

Lycopersicon esculentum. Clear mosaic mottling, banding and blistering at high temperature. At low temperature necrotic lesions were shown. Gradually the necrotic lesions disappeared and mosaic mottling then started as soon as the temperature was raised. There was clear distortion of the leaves.

Petunia hybrida. At high temperature varied symptoms of mosaic mottling, clearing of veins and blistering appeared. In winter necrotic lesions appeared in the form of ringspots.

Cucumis sativus showed clear mosaic mottling at high temperature. *Gomphrena globosa*, *Helianthus annuus* and *Solanum tuberosum* showed faint mosaic mottling.

A group of five plants developed local lesions. These were: *Chenopodium amaranticolor*, *Chenopodium murale*, *Datura stramonium*, *Nicotiana glutinosa* and *Nicotiana rustica*.

At high and low temperatures, within 4—5 days, inoculated leaves developed large numbers of necrotic lesions in the form of concentric rings, or rings and necrotic patches wich nearly always fused and formed dead areas. The leaves then shrivelled, dried out and dropped. There was no systemic infection.

The following list did not react to inoculation: *Amaranthus tricolor*, *Brassica oleracea*, *Ipomaea batatas*, *Lactuca sativa*, *Pelargonium zonale*, *Phaseolus vulgaris*, *Raphanus sativus*, *Vicia faba* and *Vigna sinensis*.

Back inoculation to pepper plants from the infected plants of the first group produced very clear mosaic mottling on the inoculated pepper plants. No symptoms developed on healthy pepper plants when inoculated from the apparently immune species of the second group.

Application of the squeezed sap from the necrotic areas from *Chenopodium amaranticolor*, *Chenopodium murale*, *Nicotiana glutinosa*, *Nicotiana rustica* and *Datura stramonium* to healthy pepper leaves induced mosaic mottling. However, application of this sap from the surrounding leaf did not induce the disease under investigation to the inoculated pepper plants.

4. *Physical properties of the virus.*

a) *Thermal inactivation point.* The virus was completely inactivated in undiluted clarified sap from pepper leaves when heated for 10 minutes at 94 °C.

b) *Dilution end-point.* When sap from infected pepper seedlings were diluted with distilled water, infection was obtained at 10^{-6}.

c) *Resistance to ageing.* Undiluted sap containing the virus was infectious for 50 days at room temperature (approximately 23—28 °C).

5. *Serological reactions.* Maximum dilution of clarified sap from pepper plants inoculated with the virus from natural infection and necrotic lesions showed positive precipitation reaction to 1:128 and 1:64 respectively, when tobacco mosaic virus antiserum diluted to 1:32 was added.

Pepper plants inoculated with expressed sap from all tested plant species were tested serologically to tobacco mosaic virus antiserum. Pepper plants inoculated with sap from inoculated plants of the first group showed positive precipitation reaction. On the other hand, pepper plants inoculated with sap from inoculated plants of the second group gave negative precipitation reaction with the antiserum, suggesting that these plants were immune to tobacco mosaic virus. This was in agreement with the transfer trials mentioned previously.

Discussion

Pepper plants (*Capsicum frutescencs*, L. var. *grossum*, Bailey, bell or sweet pepper) were found to be naturally infected by a mosaic disease and curling of leaves. The disease has been transferred to healthy pepper plants with sap.

Host range of the causal agent coincided with that of tobacco mosaic virus. On tobacco, petunia and tomato leaves, the virus produced small local lesions and systemic mosaic and necrotic local lesions on *Chenopodium*, *Datura*, *Nicotiana glutinosa* and *Nicotiana rustica*. This agreed with the findings of HOLMES (1928), HOLMES (1932) and HOLLINGS (1956) respectively. Similarly it induced mosaic symptoms, on *Cucumis sativus*, *Gomphrena globosa*, *Helianthus annuus*, *Solanum tuberosum* and this agrees with the findings of HOLMES (1946).

The virus gave infection slightly above 10^{-6} and its thermal inactivation point was 94 °C. The virus was capable of retaining its infectivity for 50 days at room temperature. These results were obtained by many workers such as PRICE (1933), HOLMES (1928) and GIGANTE (1957).

Precipitation reaction of the virus extracted from pepper seedlings inoculated with: a) the natural virus, b) necrotic lesions and c) the infected plant species with tobacco mosaic virus antiserum, proved to be tobacco mosaic virus.

Thus from the above-mentioned results and conclusions it may be deduced that the virus causing leaf curl of pepper is a strain of tobacco mosaic virus.

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STIMULATIVE EFFECT OF ALPHA-NAPHTHYL-ACETIC ACID AND BETA-INDOLYL-BUTYRIC-ACID ON ROOT DEVELOPMENT OF CURRANT CUTTINGS

By

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Currant varieties imported from various countries were propagated by soft and semi-hard cuttings. Prior to propagating cuttings were treated with various concentrations of the rooting stimulants alpha-naphthyl-acetic acid and beta-indolyl-butyric-acid. With soft cuttings used it was found that the variety Jonkheer van Tets gave the best results when treated with 3000 ppm concentration of beta-indolyl-butyric acid, while the variety Red Lake with 5000 ppm concentration of the same chemical. When using semi-hard cuttings we found a 3000 ppm beta-indolyl-butyric acid treatment applied to both varieties Jonkheer van Tets and Red Lake the best. Varieties Macheraus Späte Riesentraube and Croseille Raisin died in spite of careful attention.

Introduction

Our aim was to spread the new currant varieties in Hungary, to grow them profitably and find out which method is the best in propagating currant by soft and semi-hard cuttings. From the Hungarian and international literature pertaining to the subject only the most important works are mentioned.

Fillmore (1954), Lubinsky (1957), Doesburg–Douglas (1958), Richardson (1958), Bulda (1961), Fernquist (1962), Anisimov (1963), Porpáczy (1964), Mezei (1968, 1969) and Probocskai (1969) pointed out that rooting stimulants and various ecological and biological factors have different effects on the root development and duration of life of soft and semi-hard cuttings. When propagating currant by cuttings optimum time and treatment should be determined for each variety separately.

Material and Method

The examined currant varieties: Jonkheer van Tets, Red Lake, Macheraus Späte Riesentraube and Groseille Raisin were planted in 1965 at the Balatonbozsok and Enying stations of the Badacsony State Farm.

Soft cuttings were made of these varieties on 30th and 31st May, 1969. Experiments were set up according to the following arrangement. 50 cuttings per each variety were dipped for 60 seconds into beta-indolyl-butyric acid and alpha-naphthyl-acetic acid of 3000, 4000 and 5000 ppm concentration respectively, in three replications. Soft currant cuttings were placed in garden frames immediately after dipping. Frames were laid with peaty faeces at the bottom and a layer of river-sand on the top of them; cuttings were placed in this layer in a random design with care taken of the leaves of cuttings not to touch each other. The necessary air humidity was provided for by sprinkling irrigation. Green cuttings were shaded and great attention was paid to ventilation. On 9th and 10th July, 1969, rooted cuttings were removed and placed into pots.

On 30th and 31st August, 1969 propagation of the above varieties was attempted by semi-hard cuttings used as well. Replications and treatments were carried out in the same way as with the soft cuttings. Rooted semi-hard cuttings were placed in pots on 13th October, 1969, and will be planted out in spring.

Results

Significant difference in root development as compared to the control was found at a $P = 10\%$ level only with Jonkheer van Tets green cuttings treated with beta-indolyl-butyric acid of 3000 ppm concentration.

In varieties Jonkheer van Tets and Red Lake green cuttings treated with beta-indolyl-butyric acid proved generally better. No significant difference could be found, however, between alpha-naphthyl-acetic acid and beta-

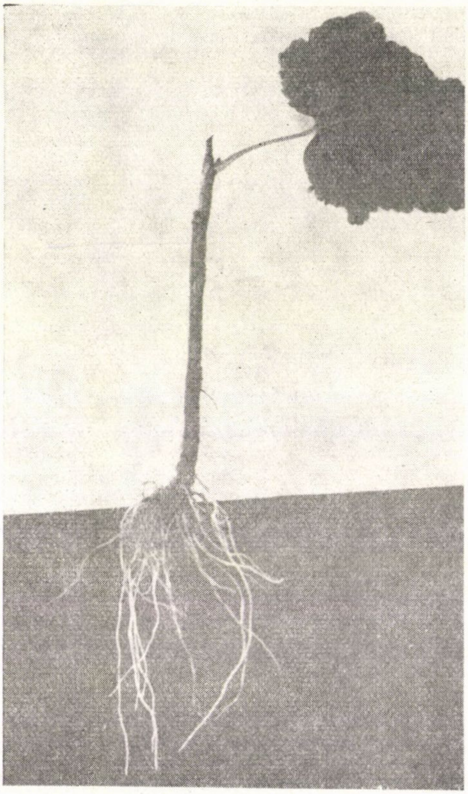

Fig. 1. Satisfactory root development of Red Lake propagated by green cuttings treated with beta-indolyl-butyric acid of 3000 ppm

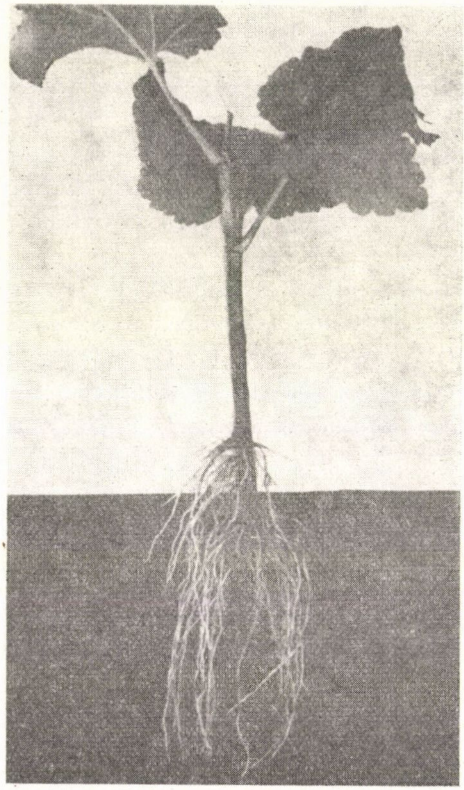

Fig. 2. Green cuttings of Red Lake developed more roots when treated with 5000 ppm beta-indolyl-butyric acid than when treated with a 3000 ppm concentration of the same chemical

Table 1

Percentage of root development of green cuttings of various currant varieties treated with root stimulants

July 9—10, 1969

Varieties	Treatments						
	3000 ppm α-naphthyl-acetic acid	4000 ppm α-naphthyl-acetic acid	5000 ppm α-naphthyl-acetic acid	3000 ppm β-indolyl-butyric acid	4000 ppm β-indolyl-butyric acid	5000 ppm β-indolyl-butyric acid	Control
Jonkheer van Tets	21.3	20.0	18.1	34.0	32.6	31.3	22.0
Red Lake	40.0	44.6	35.3	41.3	39.3	46.6	38.6
Macheraus Späte Riesentraube	0	0	0	0	0	0	0
Groseille Raisin	0	0	0	0	0	0	0

Table 2

Percentage of root development of semi hard cuttings of various currant varieties treated with root stimulants

October 13, 1969

Varieties	Treatments						
	3000 ppm α-naphthyl-acetic acid	4000 ppm α-naphthyl-acetyc acid	5000 ppm α-naphthyl-acetyc acid	3000 ppm β-indolyl-butyric acid	4000 ppm β-indolyl-butyric acid	5000 -pm β-indoyl-butyric acid	Control
Jonkheer van Tets	50.6	49.3	41.3	64.0	61.1	56.6	20.6
Red Lake	8.6	8.0	11.3	60.0	51.3	41.3	20.0
Macheraus Späte Riesentraube	0	0	0	0	0	0	0
Groseille Raisin	0	0	0	0	0	0	0

indolyl-butyric acid treatments. In both varieties percentage values of rooting are higher in case of beta-indolyl-butyric acid treatment.

A difference significant at P = 10% level was found between varieties Jonkheer van Tets and Red Lake treated with 3000, 4000 and 5000 ppm alpha-naphthyl-acetic acid.

Varieties Macheraus Späte Riesentraube and Groseille Raisin could not be propagated by green cuttings. Both treated green cuttings and controls died within 8—10 days.

Jonkheer van Tets and Red Lake varieties propagated by semi-hard cuttings treated with beta-indolyl-butyric-acid of 3000 ppm concentration showed a significant difference at $P = 10\%$ as compared to the control. With the variety Red Lake none of the alpha-naphthyl-acetic acid treatments proved to be satisfactory; all the results remained below those of the control.

Treatments with 3000, 4000 and 5000 ppm concentrations of beta-indolyl-butyric acid were efficient in case of varieties Jonkheer van Tets and Red Lake. With the variety Jonkheer van Tets treatment with alpha-naphthyl-acetic acid gave satisfactory results as well.

In the treatments no significant differences could be found at 5%, 1% and 0.1% levels, that is why s.d. values are not presented in the tables. On the basis of our investigations with the varieties Jonkheer van Tets and Red Lake 3000 ppm beta-indolyl-butyric acid treatment is recommended to be used in production.

Conclusions

When using root stimulants, choice of the optimum state of the shoots is very important. It depends also on the variety.

Among the root stimulants beta-indolyl-butyric acid proved to be the best in our experiments.

In varieties Jonkheer van Tets and Red Lake green cuttings treated with beta-indolyl-butyric acid were superior to the control.

Further experiments are required to determine the time when the state of the shoots is the most suitable for rooting.

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RELATION OF FLOWERING TO TEMPERATURE IN HUNGARIAN APRICOT

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In the Danube—Tisza Mid-Region the dormant stage of apricot flower buds ends in the middle of December — as shown by the heat calculations. When calculating the amount of heat required for flowering effective daily mean temperatures above 3 °C can be best used. The actual biological zero point is, on the other hand, lower than that. From 16th December, with daily mean temperatures above 3 °C totalled, effective amount of heat required for the flowering of apricot is — on the average of 10 years — 199.8 degrees, with a dispersion of 14.9 degrees (7.5 per cent).

Introduction

According to Szalai (1968), the state of dormancy is restricted to the meristems and to organs containing meristems. The dominant role of meristems is emphasized by Moroz (1948) and Metlitzkiy—Korableva (1965) as well.

Elmanov (1959) sees the biological essence of dormancy — as related to apricot and other stone fruits — in the following: As a consequence of low temperatures and reduced respiration metabolism acts in the direction of starch synthesis and starch accumulates mainly in the ground tissue of the bud. The necessity of low temperature ends with maximum starch content (in the ground tissues of buds). By that time pollen mother cells have developed in the anther. If in November and December the temperature is high, buds will be killed not being able to accumulate sufficient quantites of starch, since it is used for improductive respiration.

Mándy—Kárpáti (1958) divide the state of dormancy into the following phases: pre-dormancy, complete dormancy and post-dormancy.

Data on the termination of dormancy are highly varied due to differences in regions, varieties and seasons. According to Ionova (1958) it takes place at the end of October or at the beginning of November, while it is considered to be in December by Nyujtó—Tomcsányi (1959), Berezenko (1963), Malik—Cejka (1965), in January by Elmanov (1961) and in February by Cojeneau (1958).

Malik—Cejka (1965) determine the threshold of heat required for development in a daily mean temperature of 6.5 °C, Nyujtó—Tomcsányi (1959) in 5 °C, while Vitanov (1963) in 0 °C.

According to **Nyujtó—Tomcsányi** (1959) the total amount of heat required for flowering is 141 °C with daily mean temperatures above 5 °C, while **Vitanov** (1963) gives a heat amount of 248 °C totalled from daily mean temperatures above 0 °C and measured from the 1st February. On the other hand, **Anstey** (1966) found that the maximum amount of heat resulted in a lower variability than other methods did.

In Hungary it was **Tamássy** (1960), **Molnár** (1960), **Udvardy** (1963) and **Tétényi** (1965) who dealt intensively with questions related with dormancy in apricot.

Material and Method

Phenological observations required for the calculations were carried out in the experimental station of the Agricultural Research Institute of the Danube—Tisza Mid-Region at Cegléd. Observations have been carried on since 1958, and data of 10 years were used in the calculations with the exception of 1960. In 1960 75—95 per cent of the flower buds were destroyed by frost, therefore that year was left out of calculation. Namely, in such years those remaining flowers open which under natural conditions (without frost damage) would open during or at the end of mass flowering, that is some days later.

The first calculations were made for the average flowering date of the collection. Since, however, the collection did not represent the right proportions of varieties in the country, the new calculations were restricted to a very good clone of the best Hungarian variety.

The orchard was planted in 1951 on a medium heavy clay soil, with Armeniaca vulgaris used as root-stock. Phenological observations were performed daily on six trees, generally in the morning, so flowers opening after the daily observation were recorded only on the next day. Consequently, the phenological data may be one day late as compared to the actual date.

In the calculations the beginning of flowering was considered, when at least 1 per ceut of the buds was open. As in each case it was the fruit spurs that blossomed earlier, the total amount of heat calculated applies primarily to the flower buds of fruit spurs. Heat reqnirements of other bearing parts, e.g. secondary shoots, may be considerably different. Findings by **Rjadnova** (1958), **Sitt** (1955), **Kostina** (1953) and **Berezenko** (1963) as well as our own experimental data refer to this fact. Meteorological data were obtained from the meteorological station located at a distance of 500 m from the orchard.

Results

Total amounts of heat required for the flowering of apricot were determined first — from the 1st January, above 0 °C. On the average of 10 years it is 342 °C, and is completed on about the 8th April. **Vitanov**'s (1963) data on Bulgarian conditions are nearly the same, as he gives 248 °C from February 1, which can be expected by the end of March or beginning of April. Dispersion on the 10 years average is 32.1 degrees; the earliest date of flowering is March 27, while the latest one is April 20. Thus, even the highest extremities of the weather did not cause more than 3—4 weeks' difference in flowering in the 10 years studied.

Investigations were aimed partly at determining the end of dormancy in flower buds. Therefore the total amounts of heat above 0, 1, 2, 3, ... 10 °C were calculated with various dates of beginning (November 1 and 16, December 1 and 16, January 1). Dispersion and variation coefficient were calculated for them. Data are presented in Table 1. Supposing, that under identical conditions flowering requires the same amount of heat each year, the date heat amounts showing the lowest differences are calculated from, is accepted as terminating date of dormancy in apricot. Differences are expressed by the dispersion values. Dispersion values could not, however, be simply compared, as heat amounts totalled from January 1 were lower than those totalled from November 1, so — naturally — dispersion values relatively decreased as well. For the purpose of comparison a variation coefficient was determined, so variation of data of different order of magnitude could be compared.

The CV values (variation coefficient) of Table 1 are the lowest with heat amounts calculated from 16th December, and are not much higher than those calculated from January 1. With earlier dates CV values are higher and are the highest when heat is totalled from November 1. This date (middle of December) — with minor differences — corresponds to data obtained when forcing shoots and evaluating the winter growth of buds. Otherwise, according to literary data and our own experiments, termination of dormancy in flower buds cannot be determined by a single date. The date changes depending on whether it is related to individual buds, to an average of buds or to flower buds on the whole. Present paper considers the end of the dormant stage as a state or date when dormancy has terminated in the majority of flower buds (in 80—90 per cent of flower buds on the first growth of the fruit spur).

The other object of our investigations was to determine the biological zero point in apricot. In one of the approaches even for this purpose heat amounts calculated from various dates and various fictive heat thresholds were used (Table 1). According to the table the threshold of heat required for the development of flower buds in apricot is 3 °C, though 2 °C seems to be just as good.

After the calculations completed and on the basis of literary data the 3 °C (daily mean temperature) obtained was thought to be at the same time the biological zero point. Nevertheless, this assumption proved to be wrong. With the winter growth of buds studied, further, in other related experiments it was found that buds evidently grow even when the daily mean temperature does not reach 3 °C. Thus, the 3 °C daily mean temperature is not the wanted biological zero point, it is only a 'heat threshold' that can be used when calculating the total amount of heat required for flowering. The questions of biological zero point determined will be dealt with in another paper.

Since among the daily temperature values only the warmer zones can induce growth, and the 3 °C daily mean temperature obtained during the calculations postulates generally maxima of 5—9 °C, therefore with this heat threshold temperatures of 5—9 °C should be interpreted as active temperatures.

Table 1

Effective total heat required for flowering in Hungarian apricot
(Expressed in daily mean temperature)

(Average of 10 years)

	Above 0 °C			Above 1 °C			Above 2 °C		
	Aver. total heat	Disper sion	CV	Aver. total heat	Disper-sion	CV	Aver. total heat	Disper-sion	CV
From Nov. 1. to flowering	588.6	68.6	11.7	489.3	61.8	12.6	402.2	55.6	13.8
From Nov. 16 to flowering	468.7	54.4	11.6	382.8	44.5	11.6	310.0	34.7	11.2
From Dec. 1 to flowering	405.5	58.1	14.3	331.6	46.3	14.0	269.6	33.5	12.4
From Dec. 16 to flowering	366.4	35.7	9.8	300.9	29.0	9.6	246.8	20.7	8.4
From Jan. 1 to flowering	342.3	32.1	9.6	283.5	27.3	9.6	234.2	23.0	9.8

	Above 3 °C			Above 4 °C			Above 5 °C		
	Aver. total heat	Disper-sion	CV	Aver total heat	Disper-sion	CV	Aver. total heat	Disper-sion	CV
From Nov. 1. to flowering	326.5	49.8	15.3	267.3	51.1	18.4	210.4	52.6	25.0
From Nov. 16 to flowering	248.3	27.9	11.3	203.2	29.4	14.5	158.4	35.5	22.4
From Nov. 1 to flowering	217.4	24.0	11.0	171.4	19.1	11.1	132.1	18.3	13.8
From Nov. 16 to flowering	199.8	14.9	7.5	162.5	16.1	9.5	122.0	12.2	9.7
From Nov. 1 to flowering	190.7	19.7	9.4	156.5	16.7	12.1	118.1	16.9	14.3

The question of what is the cause of the considerable difference between the calculated heat threshold and the actual biological zero point — is raised. In this respect we have only theories. The exact cause is to be find by subsequent investigations. According to our theories and investigations started the cause of the difference should primarily be looked for in the peculiar heat energy management of buds.

Intensive insolation in fine weather is a frequent phenomenon both in winter and spring. This insolation cannot warm up the air due to the frozen soil, but at the same time warms up — depending on the albedo — objects in its way, including the buds of trees (Brown 1958). Thus life functions may start in the buds even when temperature of air is near to 0 °C (Draczinski 1958).

The difference between the two temperatures may be caused by the method of heat calculation. According to some authors, e.g. Tamás (1959) plant growth shows a parabolic regression as a reaction to increased temperature. Accordingly, the effect of a given amount of heat depends on whether it is lower or higher temperatures that make it. For example, temperatures above 15 °C induce much more intensive growth than those above 5 °C. And we — when simply totalling temperatures above an assumed threshold of heat — performed, in fact, a linear regression calculation. Consequently, if the actual relation between growth and temperature is still parabolic, then increased growth resulted from higher temperatures should be compensated for somewhere else. By the fact that the temperature obtained as a threshold is higher than it really is, the process of calculation leaves out growth reactions evoked by the lower temperatures. In other words, temperatures of those days are recorded only on which a considerable growth of buds can already be found.

It is also highly probable that parallel with the development of annual vegetation both heat thresholds and heat optimums required by the individual phenophases are to set in change.

Discussion

There are several questions raised in connection with the heat calculation. One of them is the natural contradiction between the effect of heat and the daily mean temperature considered. Namely the temperature considered does not precisely reflect the amount of heat obtained.

Another factor that could not be taken into consideration is the depression occurring in the flower buds as induced by very cold weather. On the 18th December 1963 the temperature of air fell to —22 °C, and on this account the length of pistils decreased by 9 per cent. Similar depression has been observed in other species and years as well.

Another question is whether cold causes such lesions in the cells as hindering subsequent development either temporarily or permanently. In some cases it may possibly have harmful after-effects but this has not been confirmed with data as yet. In this context the effect on flowering of negative temperatures (below 0, —5, —10 °C) was also taken into consideration. Apart from the frost damage in 1960, flowering in other years was not appreciably either stimulated or inhibited by the extent and duration of cold weather.

Since the average deviation from the amount of heat required for flowering is —14.9 °C which corresponds to deviation within a day, and phenological data are also of such reliability, total heat could not be determined with greater accuracy.

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A COMPARATIVE STUDY OF THE PROTEIN CONTENT OF SOME IMPROVED WHEAT VARIETIES AS INFLUENCED BY NITROGEN FERTILIZATION AND SOWING TIME

By

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Ten newly evolved wheat varieties were compared with 3 standard varieties with regard to their response to nitrogen fertilization under timely and late sowing conditions. The results in general show that the effects of varieties, nitrogen and sowing time on the protein content were highly significant. NP 880, HD-1111, HD-1148, NP 843, NP 847 and NP 863 with protein content varying from 11.24% to 12.84% proved to be superior to all the three standard varieties. As for the overall effect of nitrogen, the response to first dose was greater than that for the additional dose, indicating that the response is quadratic. Protein content obtained under late sowing conditions was found to be significantly higher than that under timely sowing conditions. The interaction between variety and nitrogen was found to be significant. NP 854 and the control NP 830 responded significantly only to 40 kg N fertilization. All the other varieties had a significant response to both nitrogen doses. The responses of NP 843, NP 847 and NP 863 are comparable to C 281 which has been found to be the best control in this respect. The interaction between variety and sowing time was found to be significant. Under late sowing conditions NP 863, NP 847, NP 843, HD-1148 and HD-1111 gave significantly higher protein content than all the three controls. The significant interaction between nitrogen and sowing date showed that nitrogen fertilization has a greater effect under normal sowing conditions on the increase in protein content of grains. The triple interaction: variety × nitrogen × sowing time show that under timely sowing conditions NP 863, NP 847, NP 880, NP 871, NP 857, HD-1111, HD-1148 and the controls NP 824 and C 281 responded significantly to both nitrogen doses, whereas under late sowing conditions the best varieties were NP 843, NP 863 and NP 869.

Introduction

With the recent trends of stressing quality aspects in wheat breeding programmes on scientific basis rather than on morphological characteristics of the grain, protein content is one of the major characters of grain quality. Wheat and other cereals form the main source of protein supply of the Indian population among whom malnutrition is very prevalent. With the mean protein values varying from 10 to 16%, some improved varieties developed in the recent years by the breeders in India proved to be superior to the older Indian wheats (Austin *et al.* 1962, 1968). Some of these varieties showed marked varietal responses to different doses of nitrogen fertilization, producing increased protein content (Austin—Miri 1961). These findings point out the possibility of raising the protein content in wheat by improving variety and agricultural practice. In the light of this, a number of new varieties were examined for protein content as influenced by variety, nitrogen fertilization and sowing time differences.

Material and Method

Ten improved wheat varieties, namely: NP 843, Np 847, NP 857, NP 858, NP 863, NP 869, NP 841, NP 880, HD-1111 and HD-1148 along with three standard varieties, namely: NP 824, NP 830 and C 281 were grown in the experimental farm of the Botany Division under two sowing dates (i.e. timely sowing — 15h November — S_1 and late sowing — 15th December — S_2) with three doses of nitrogen (0, 40 and 80 kg N/hectare) in form of ammonium sulphate. The experiment was conducted in split plot design in four replications with main plots as combinations of nitrogen with sowing date and sub-plots as varieties. The grain samples were taken from each replication for the determination of protein content (N×5.7) according to the usual Kjeldahl method.

Results

The analysis of variance presented in Table 1 shows that all the main effects and their interactions are highly significant. Table 2 gives the means of the main effects and their critical differences at 5% level. The data show that NP 863 having a protein content of 12.84% proved to be significantly superior to all the other varieties, while the significantly lowest value of 10.53% was found in the check variety C 281. With regard to the influence of nitrogen doses, it was found that the protein content increased with the

Table 1

Analysis of variance

Due to	DF	S.S	MSS	F values
Blocks	3	0.2033	0.0677	1.104
N	2	195.2201	97.6100**	1592.33
S	1	47.9566	47.9566**	782.326
N×S	2	14.1604	7.0802**	115.5
Error (a)	15	0.9192	0.06138	
V	12	101.7357	8.4779**	219.63
V×N	24	33.0893	1.3787**	35.717
V×S	12	28.8707	2.4059**	62.329
V×N×S	24	26.7785	1.1158**	28.906
Error (b)	216	8.3423	0.0386	

** indicates significance at 1% level.

Table 2

Mean protein percentage of dry material

Due to varieties		Due to nitrogen		Due to sowing date	
Variety	Mean protein content	Nitrogen	Mean protein content	Sowing date	Mean protein content
NP 863	12.84	No	10.29	S_1	10.94
NP 847	11.79*	N_{40}	11.51	S_2	11.72
NP 843	11.72*	N_{80}	12.20		
HD 1148	11.67*				
HD 1111	11.47				
NP 880	11.24*				
NP 830 (Check)	11.20*				
NP 824 (C)	11.18*				
NP 871	11.13*				
NP 858	11.00				
NP 869	10.81*				
NP 857	10.74*				
C 281	10.53				
CD at 5% level = 0.11		CD at 5% level = 0.07		CD at 5% level = 0.06	

* Indicates non-significant groups

Table 3

Mean protein percentage of dry material as affected by the interaction between variety and nitrogen

Variety	No	N_{40}	N_{80}
NP 863	11.21	13.23	14.08
NP 847	10.04	12.55	12.78
NP 843	10.36	11.98	12.84
HD 1148	11.01	11.62	12.38
HD 1111	10.38	11.85	12.20
NP 880	10.38	11.15	12.20
NP 824	10.29	11.61	11.70
NP 871	10.35	11.21	11.99
NP 858	10.79	10.85	11.37
NP 869	9.99	10.57	11.88
NP 857	9.50	11.27	11.45
C. 281	9.09	10.73	11.76

CD for (V × N) at 5% level = 0.19

application of nitrogen. As for the effects of sowing date, the protein content was significantly higher under late sowing conditions.

The interactions between varieties and nitrogen presented in Table 3 show that all the varieties except NP 857, NP 858 and one of the controls NP 830 produced significantly higher protein content with the application of 40 and 80 kg N. NP 830 and NP 857 responded significantly only to 40 kg N, whereas NP 858 required 80 kg N. The performance of NP 847, NP 863, NP 843 and the standard C 281 was found to be especially superior.

The results of the interactions between varieties and sowing dates presented in Table 4 show that NP 863 has given the highest protein content under both timely and late sowing conditions. NP 863, NP 847, NP 843, HD-1111 and HD-1148 under late sowing conditions produced significantly higher protein content than all the 3 controls. Under late sowing conditions NP 880 showed no specific increase, while NP 824 showed a significant decrease in protein content.

The significant interactions between nitrogen and sowing dates presented in Table 5 show that the increases in protein content as affected by fertilization were not similar under the two sowing times. Under normal sowing conditions 40 kg and 80 kg N produced increases of 15% and 24%, respectively over the control, while under late sowing conditions the increases

Table 4

Mean protein percentage of dry material as affected by the interaction between variety and sowing

Variety	S_1	S_2
NP 863	12.12	13.55
NP 847	11.55	12.03
NP 843	11.15	12.30
HD 1148	11.30	12.04
HD 1111	10.56	12.39
NP 880	11.24	11.25
NP 830	10.72	11.68
NP 824	11.50	10.86
NP 871	10.81	11.44
NP 858	10.71	11.29
NP 869	10.13	11.49
NP 857	10.44	11.04
C 281	10.02	11.03

CD for (V × S) at 5% level = 0.16

Table 5

Protein percentage as affected by the interaction between nitrogen and sowing time

Nitrogen dose	Sowing date		
	Timely	Late	Mean
N_0	9.63	10.94	10.29
N_{40}	11.12	11.91	11.52
N_{80}	12.08	12.32	12.20
MEAN	10.94	11.72	

CD for (V × S) at 5 % level = 0.10

were only of 8% and 12%, respectively. This shows that the nitrogen fertilization is more beneficial under normal sowing conditions. Under both sowing dates the application of the two doses of nitrogen produced significantly higher protein content.

The triple interaction: variety × nitrogen × sowing time is presented in Table 6. Under normal sowing conditions NP 843 and the control NP 830 gave significant response to 40 kg N, but no additional response was obtained

Table 6

Mean protein content of dry material as affected by the interaction: variety × nitrogen × sowing time

Variety	S_1 (Timely sowing)			S_2 (Late sowing)		
	N_0	N_{40}	N_{80}	N_0	N_{40}	N_{80}
NP 863	9.94	12.53	13.90	12.48	13.92	14.26
NP 847	9.86	12.18	12.62	10.22	12.92	12.94
NP 843	9.79	11.78	11.87	10.92	12.18	13.81
HD 1148	10.34	11.41	12.14	11.67	11.83	12.62
HD 1111	9.47	10.77	11.43	11.28	12.92	12.96
NP 880	9.57	11.05	13.10	11.19	11.25	11.30
NP 830	9.21	11.41	11.53	11.37	11.81	11.87
NP 824	9.89	11.58	13.04	10.80	10.85	10.94
NP 871	9.78	10.98	11.66	10.91	11.16	12.26
NP 858	10.36	10.39	11.38	11.22	11.30	11.35
NP 869	9.49	9.69	11.21	10.48	11.45	12.54
NP 857	9.08	10.95	11.31	9.92	11.59	11.60
C 281	8.46	9.80	11.81	9.73	11.66	11.70

CD for (V × N × S) at 5% level = 0.27

when applying another 40 kg N. NP 858 and NP 869 which did not give significant response to 40 kg N, showed significant increase with 80 kg N. All the other varieties responded significantly to both nitrogen doses. NP 863, NP 880, NP 824 and C 281 have been found to be especially superior to the other varieties considering their response to nitrogen fertilization.

Under late sowing conditions NP 858, NP 880 and the check variety NP 824 did not show any beneficial response to nitrogen fertilization, whereas NP 843, NP 863 and NP 869 showed beneficial response to both nitrogen doses. It may be noted that among the varieties only NP 863 proved to be excellent under both the sowing dates, concerning the nitrogen responses. NP 847, HD-1111, NP 857 and 2 of the controls, namely: NP 830 and C 281 responded only to 40 kg N, whereas NP 871 and HD-1148 required 80 kg N of it to produce a significant increase in protein content.

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A LARGE-LEAVED SPONTANEOUS MUTATION OF LUPINUS LUTEUS L.

By

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In 1961 the authors found a new large-leaved spontaneous mutation in the lupine variety "Gyulatanyai 784". In the progeny of the mutant the authors studied the morphology of the leaf (leaflet), and some of the characteristics related to productivity in order to obtain preliminary information. The leaf-variation of the mutant was compared with the corresponding data of the initial variety and the wild lupine, while characteristics related to productivity with those of the initial variety only. On the basis of variation analyses leaf measurements of variations examined were found to be significantly different. The size of the leaflets increased in the following order: wild lupine — initial variety — mutant. When compared to the initial variety difference in length was +15.3 per cent, while in width it was +37.3 per cent. Differences were found also in the type and variation range of frequency distribution in leaf width. It was found further, that mutation effect affected not only the dimension but also the shape of the leaflet. Length/width ratio of leaflets is lower in the mutant than in the initial variety. According to authors' investigations seed production of the mutant proved to be lower than that of the initial variety. They point out, however, that one year is too short a time to consider the differences found as final, and further investigations carried out with a higher number of plants are required. Authors think that it is probable that the new mutant — as a crossing partner — may become valuable basic material of breeding.

Introduction

Frequency of occurrence of both spontaneous and induced mutations is relatively high in the lupine varieties (Hackbarth–Troll 1959). Majority of morphological mutants found in *L. luteus* showed changes in the colour of leaves (Hackbarth 1957). Only two mutations affecting the leaf shape and leaf measurements respectively, have been known so far: the "macromutant" 1, described by Edwardson–Corbett (1969), where leaf blades are grown together in a funnel-like fashion, and the "digitate-leaved" mutant observed by Troll (1959), where the number of leaflets has multiplied.

Hackbarth–Troll (1959) consider leaf measurements as important characteristics worth paying attention to from a breeding point of view, and in the case of lupines leaf is a yield component as well.

Stoy (1953) attributes an important role to the leaf surface area when development of more productive varieties is considered. In his opinion good utilization of solar energy by the given plant — that is, the largest possible quantity of dry matter accumulated — is a decisive precondition of obtaining highly productive varieties. This statement seems to be confirmed by SCHOLZ's observation (1957). In his experiment the broad-leaved mutant of winter barley gave higher seed yield than the normal leaved control in two of the three years of the experimental period. On the other hand, ZACHOV (1960) found no definite correlation between leaf measurements, green yield and seed production when studying *L. luteus* mutants of different hairiness.

This paper presents a new large-leaved spontaneous mutation found in 1961 in the test plot of the variety "Gyulatanyai 784". The mutant has non-scattering white seeds and a low alkaloid content. It differs remarkably from the initial variety with the larger size of its leaves and leaflets. Temporarily the name "macrophyllus" has been given to it.

Our investigations were aimed at determining precisely the measurements of the leaflet and gaining information on the economic and breeding value of the mutant by comparing several characteristics of the variety Gyt. 784 and the large-leaved mutant.

Material and Method

Variation analyses were carried out in 1968 with 60 plants in each type. Plants originated from plots hand sown on March 26 with a spacing of 20×10 cm. The following major characteristics were examined: leaflet number of leaves, length and width of leaflets, fresh weight of plants, individual seed production, pod number per plant and seed number per pod.

Leaf examinations were performed in the eighth leaf from the base of the plant. Length and width of each leaflet were measured. At the time of the examination plants were at the end of flowering, in the phase of pod formation.

Data were evaluated with the usual method of biometry.

Results

Morphological peculiarities of the mutant's leaves were compared with those of the initial variety and of the wild lupine, while characteristics related to productivity only with the corresponding data of the initial variety.

Fig. 1 shows one characteristic leaf of each of the examined types, while Fig. 2 several leaf types of the mutant. Data are summarized in Tables 1 and Fig. 3. Subsequently, characteristics examined are dealt with one by one.

Leaflet number of leaves (Fig. 3 A). Determination of the characteristic leaflet number requires further investigations. Data, however, suggest a change in the leaflet number of the mutant's leaf. Leaves with 10 and 11 leaflets occur with a very high frequency as compared to leaves with 9 leaflets of the initial variety. The frequent occurrence of leaves with 11 leaflets is remarkable in the wild type.

Fig. 1. Photocopy of one characteristic leaf of each yellow lupine variety examined

Table 1

Statistical evaluation of characteristics examined in the wild variety, the initial variety and the mutant
Gyulatanya, 1968

Varieties	Characteristics examined	Number of observation (n)	Mean value mm $\bar{x}$	Error of the mean value $(s\bar{x})$	Dispersion (s)	Variation coefficient (CV %)	S.d. 0.1%
Wild variety	Length of leaftlets (mm)	592	44.83	±0.26	6.40	14.3	1.204
Gyt. 784		526	49.52	±0.25	5.74	11.6	1.326
Mutant		574	57.12	±0.31	7.43	13.0	
Wild variety	Width of leaflets (mm)	592	9.66	±0.08	1.89	19.6	0.333
Gyt. 784		526	11.45	±0.06	1.44	12.6	0.458
Mutant		574	15.73	±0.12	2.89	18.4	
Gyt. 784	Individual seed production	60	6.56	±0.24	1.88	28.6	0.50
Mutant		60	4.55	±0.30	2.34	51.4	
Gyt. 784	Pod number per plant	60	16.33	±0.65	5.09	31.1	2.32
Mutant		60	10.31	±0.51	4.00	38.7	
Gyt. 784	Seed number per pod	60	3.33	±0.20	1.27	38.1	0.16
Mutant		60	3.08	±0.16	1.20	38.9	

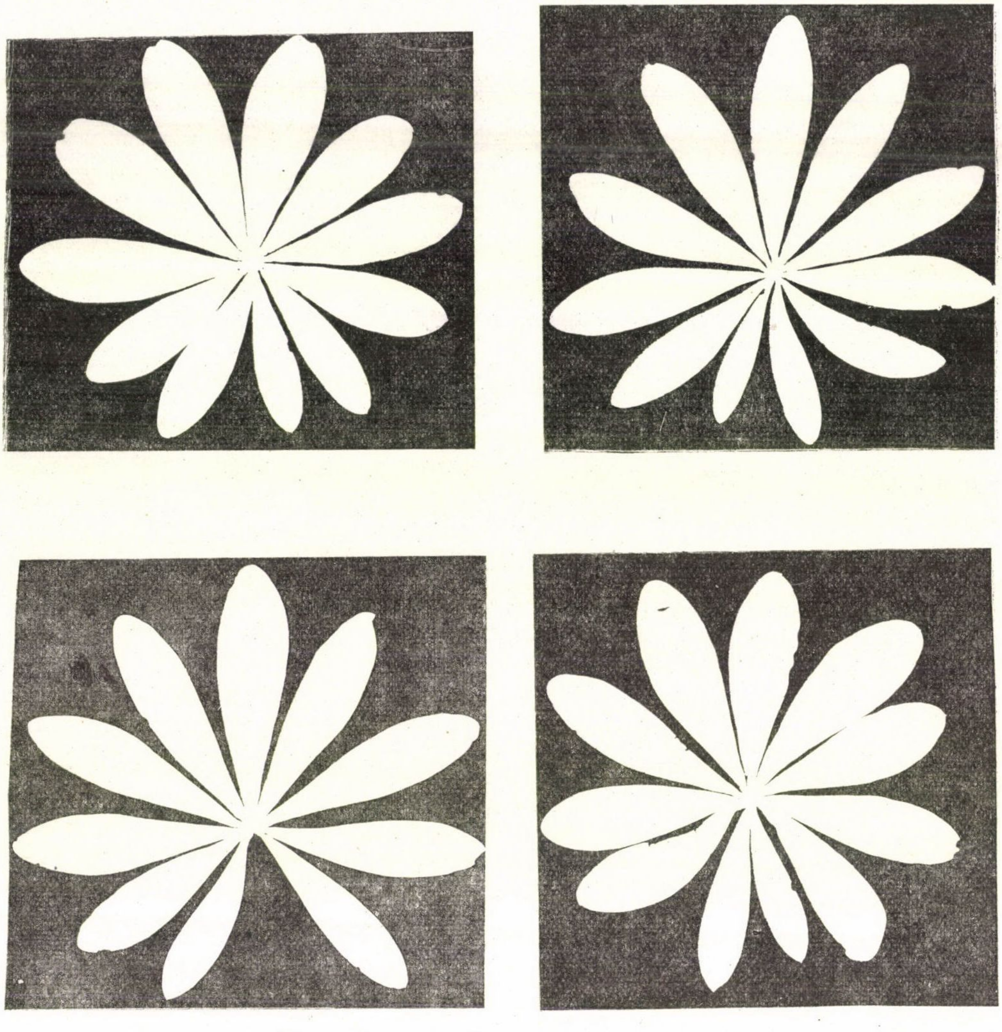

Fig. 2. Various leaf types of the mutant

Length of leaflets (Fig. 3 B). Leaflets of the mutant are significantly longer ($\bar{x} = 57.12$) than those of either the initial variety ($\bar{x} = 49.52$) or the wild type ($\bar{x} = 44.83$). The difference is significant: +15.3 per cent and + 27.4 per cent as compared to the initial variety and the wild type respectively.

There is no considerable difference in variation range between the varieties. In the case of the mutant the mode is much more on the right, at the higher value, but its class frequency is lower than in both varieties. The variation curve of the mutant shows a frequency close to the normal distribution.

Width of leaflets (Fig. 3 C). The leaflets of the mutant are significantly wider ($x = 15.73$) than those of both varieties ($x = 11.45$; $\bar{x} = 9.66$). Leaflets of the mutant are 37.3 per cent wider than those of the initial variety and 62.8 per cent wider than the leaflets of the wild lupine.

The trend of polygons shows that the leaflets of the mutant are essentially different from both varieties not only in width but also in frequency distribution. The range and extent of variation is higher in the mutant.

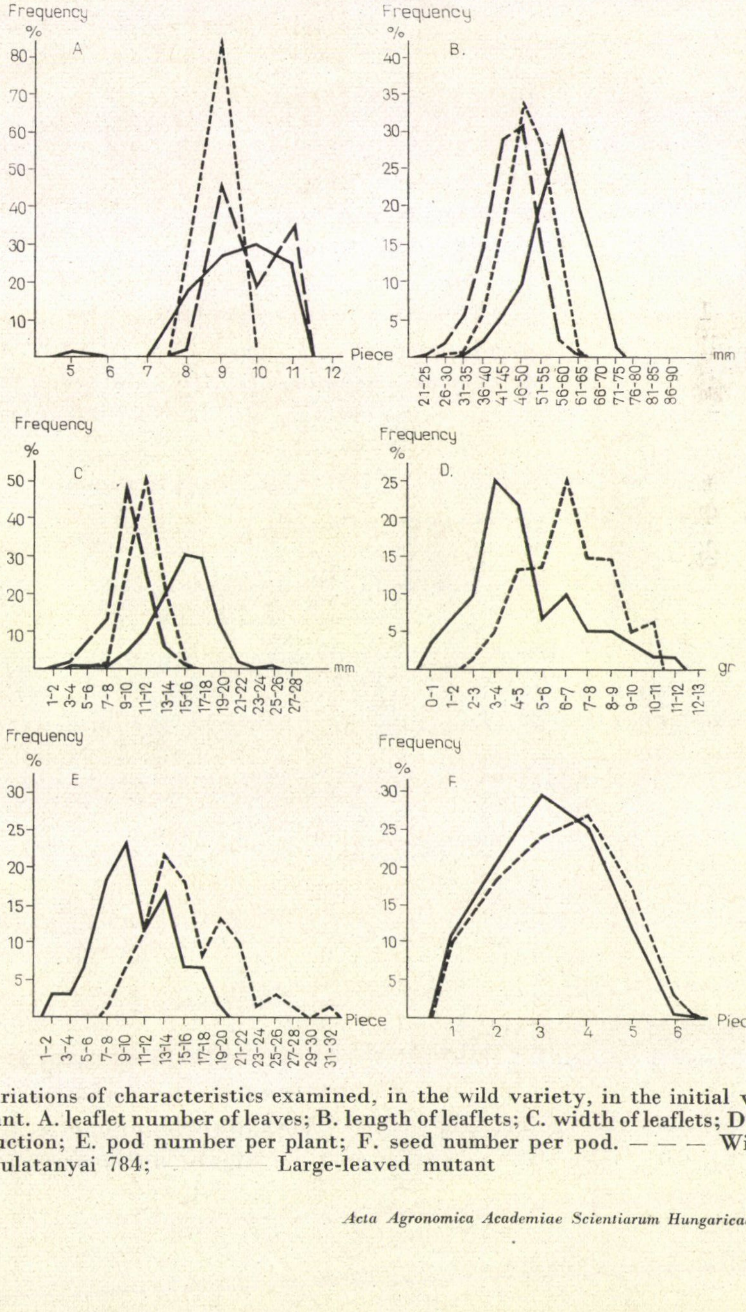

Fig. 3. Variations of characteristics examined, in the wild variety, in the initial variety and in its mutant. A. leaflet number of leaves; B. length of leaflets; C. width of leaflets; D. individual seed production; E. pod number per plant; F. seed number per pod. — — — Wild variety; - - - - Gyulatanyai 784; ———— Large-leaved mutant

Fresh weight of plants. Plants were cut off at 6 cm above the soil surface. Leaves and stems were weighed separately. (Unfortunately only five plants per variety could be weighed.) The following average weights per plant were obtained (g):

	Leaf	Stem	Whole plant
Initial variety	39	40	79
Mutant	60	65	125

If the above differences are confirmed later, the mutant is expected to surpass the initial variety in green mass.

Individual seed production (Fig. 3 D). According to the mean values seed production of the mutant ($x = 4.55$ g) is significantly lower than that of the initial variety ($x = 6.56$ g). In the initial variety variation range is 4.5 g (6.25–10.75 g), while in the mutant it is 10.75 g (0.25–11.00 g). Variation range as well as the high variation coefficient obtained in the mutant (51.42 per cent) call attention to the extreme variability of individual seed production.

Pod number per plant and seed number per pod. According to the data both characteristics are inferior in the mutant. The pod number is significantly higher in the initial variety ($x = 16.33$) than in the mutant ($\bar{x} = 10.31$) (Fig. 3 E). The latter shows higher variability.

Regarding seed number per pod the initial variety is better again (Fig. 3 F). No appreciable difference can be found, however, in the extent of variability. Comparison between the two characteristics reveals that difference in favour of the initial variety is essentially greater in pod number per plant than in seed number per pod.

Data point out at the same time that the lower seed production of the mutant is, in fact, the consequence of the lower number of pods per plant.

Discussion

On the basis of the results of investigations the following differences can be established between the leaves (leaflets) of the initial variety and those of the mutant:

1. Leaves of the mutant are significantly larger — due to the greater length and width of leaflets.

2. No considerable difference can be found in the variation in length of the leaflet, while the variation in width — both in the character of frequency distribution and in the range of variation — is highly different.

3. The mutation has affected the shape of the leaflet too, since leaflets of the mutant are 15.3 per cent longer and 37.3 per cent wider on the average.

Change towards the "macrophyllous character" can be considered favourable (HACKBARTH—TROLL 1959, SCHOLZ 1957, STOY 1963). In our own investigations, however, no favourable change occurred in seed production as an effect of the larger leaves. On the contrary, among factors determining the amount of seed production characteristics examined were, on the average, of lower value in the mutant. Individual seed production of the initial variety proved to be significantly higher under the given conditions of examination, due primarily to the considerably higher number of pods.

Differences obtained, though statistically proved, cannot be considered as final due to the low number of plants examined. Thus, practical importance of the mutant can be assessed only after obtaining data of several years investigation on the basis of a higher number of plants. Analysis of data, and the higher variability of certain characteristics suggest however, that the new mutant may become a valuable initial material for further breeding work.

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EFFECTS OF LOW DOSES OF FAST NEUTRONS AND GAMMA RAYS ON THE HUNGARIAN RICE VARIETY DUNGHAN SHALI

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Results of a pot culture experiment are reported. Improved germination and stimulated early seedling growth with better root and shoot development were recorded under treatments with 50 and 100 rads. Seedlings treated with low doses showed increased N-P uptake. Flowering duration was not found to be affected.

Introduction

Though growth stimulation by low doses of radiations in different crops has been reported by many workers (Bowen *et al.* 1963, Sax 1963, Süss–Haisch 1964), reports on such studies with rice were not found even among papers presented at the FAO/IAEA Panel Meeting held in Rome in June 1964. Results of a pot culture experiment with Dunghan Shali variety of rice (*Oryza sativa* L. sub. sp. *japonica*) applying four doses of fast neutrons and gamma rays are dealt with in this paper.

Material and Method

Dry seeds (moisture content about 13 per cent) were irradiated with 50, 100, 150 and 200 rads fast neutrons (SNIF, Austrian ASTRA reactor) and gamma rays (^{60}Co gamma cell). The irradiations were performed at the IAEA Laboratories, Seibersdorf, Austria, and the crop grown in pots at the Galambos experimental farm of the Research Institute for Irrigation and Rice Cultivation, Szarvas, in summer, 1969. Four hundred seeds were treated in each case, and sown in four replications. The same number of seeds with four replications served as control.

The early observations on germination and seedling growth were based on all the four replications, whereas the length and weight measurements of shoot and root and the N–P estimations of shoot were based on the seedlings from one replication. Thus the observations, one month after sowing, were based on three replications.

In determining N–P contents of seedlings the method of Sarkadi–Krámer (1961) was used.

Results

Germination and plant survival. A general increase in germination ranging from 12 to 20 per cent over control was observed in all the treatments. The plant survival up to flowering was also found to be more in the treated

Table 1

Effect of low doses of radiation on germination, growth, and plant survival in rice

Treatments	Germination percentage		Survival percentage up to maturity		Seedling/plant height in cm		
	Actual	Rel.	Actual	Relative	2 weeks	At 1 month	Flowering
Fast neutrons, rads							
50	86.25	113.11	80.00	126.32	11.54	22.73	65.14
100	88.00	115.40	86.00	135.80	12.76	21.30	62.87
150	88.50	116.06	78.00	123.16	11.86	21.96	66.60
200	92.25	120.98	82.00	129.48	12.05	19.88	62.73
Gamma rays, rads							
50	88.50	116.06	80.66	127.36	12.26	22.65	69.71
100	90.25	118.36	75.33	118.95	11.84	22.41	69.58
150	88.50	116.06	77.33	122.11	12.79	22.31	69.80
200	86.00	112.77	76.00	120.01	12.50	21.02	61.27
Control	76.25	100.00	63.33	100.00	11.45	22.05	68.21

Table 2

Characteristics of one-month-old seedlings from rice seeds subjected to low doses of radiations

Treatments	Weight in mg per seedling		Shoot/Root	N-P content of shoot in dry weight percentage		N/ P
	Shoot	Root		N	P_2O_5	
Fast neutrons, rads						
50	128.12	57.62	2.22	3.02	0.47	6.43
100	113.00	50.50	2.24	2.83	0.44	6.43
150	84.67	46.08	1.84	2.94	0.44	6.68
200	103.40	48.68	2.12	3.39	0.45	7.53
Gamma rays, rads						
50	105.32	48.36	2.18	3.05	0.47	6.49
100	106.12	50.32	2.11	3.36	0.49	6.86
150	94.34	49.67	1.90	3.28	0.43	7.63
200	91.53	42.17	2.17	3.05	0.44	6.93
Control	92.19	43.17	2.14	3.24	0.52	6.23

lots, by 18—35 per cent. **Süss—Haisch** (1964), **Süss** (1966), **Tavcar** (1966) and **Silvy** (1969) have recorded stimulation of germination by low doses of radiation in cereals.

Early seedling growth and plant height. Seedling height in treated lots within two weeks of sowing was found to be 11 per cent over the control; but at one month stage this height difference was quite insignificant, even negative in some cases. The height of treated plants at flowering time was also similar to that of the control. Early growth stimulations of such a kind in seedlings were found by **Süss** (1966), **Tavcar** (1966) and **Silvy** (1969) in other cereals, too.

Root and shoot weight of seedlings. Data on mean weight of shoot and root of seedlings one month after sowing are presented in Table 2. At this stage of growth the lenght of the longest root and that of the shoot up to the tip of the longest leaf were not found to demonstrate the real morphological make-up of the seedlings. This is why the weights were determined after one day drying on blotting paper in green-house at 25 °C and keeping in exsiccator for one week.

There were increases in the weight of shoot as well as root per seedling in the 50 and 100 rads treatmens of both fast neutrons and gamma rays, though at this stage these treatments had more seedlings per pot than the control because of the higher germination percentage. The shoot/root ratio was not found to be significantly affected. **Sparrow** (1966) recorded root growth stimulation by low doses of x-rays in *Tradescantia paludosa* cuttings, **Tavcar** (1966) by low doses of gamma rays in winter wheat, winter barley and maize, and **Silvy** (1969) by low doses of gamma rays in rice, maize and barley.

N—P contents of one month old seedlings. As can be seen from the data in Table 2, doses of 50 and 100 rads of both fast neutrons and gamma rays caused increase in the total P_2O_5 content per seedling, at the same time having no significant effect on the N/P ratio. **Simonis** (1966) is of the opinion that phosphate uptake may be directly or indirectly influenced by irradiation.

Flowering duration. The flowering duration was uniformly 80 days in the treatments as well as in the control. The delayed sowing (14th July) made the flowering duration much shorter, and hence these data cannot be considered to indicate any possible influence on flowering duration in the case of a normal sowing time.

Though the pots with plants were transferred to the green-house from the onset of colder days outside, all the plants in the treatments as well as in the control were 100 per cent sterile, due probably to the low temperature at the critical stage of meiosis. Thus, further comparisons on grain yield, etc. could not be made.

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EFFECT OF SEASONS ON THE MILK PROTEIN AND CASEIN CONTENT

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Seasonal effects on the milk protein and casein content have been studied in Hungarian spotted × Jersey crosses (50 and 25 per cent Jersey blooded). Hungarian-spotted populations were used as controls. It was found that the milk protein and casein content of each group showed the maximum value during winter whereas the minimum value was recorded in summer; i.e. in July and August. However, this phenomenon cannot be regarded as general.

Introduction

Several workers on the field claim that the milk protein and casein content as affected by seasonal variations could merely be based on nutrition itself. The changes ensuing in temperature of the environment may essentially be related to the effect of different seasons. There are numerous reports which deal with that problem. Most of investigators have compared the averages of samples of "mixed-milks" or individual milk-samples which were derived from cows of different stages of lactation. Hence, the cause of the variances in the dry-matter and protein contents can, on the one hand, be sought in the differences of the lactation periods, and on the other hand in the seasonal variations.

The equal frequency of calvings during the year is of both farm and national economic interest (i.e. balanced milk-supply), although there are more calvings in the late-winter and spring under our climatic conditions. Thus more cows are in the first half of lactation in spring and summer than in other seasons. In itself, this affects necessarily the composition of the milk, too. Unfortunately, such circumstances make the proper evaluation of the seasonal effects on the composition of milk more difficult.

JOHANSSON (1961) reports on experiments in which cows were kept under controlled temperature. Rising the temperature up to 50°—105° F there was observed a decrease in the fat-free dry matter content of the milk, and an increase in it when reducing the temperature to 50°—5° F. SMITH (1960) referring to the experiments carried out in Tucson (United States) suggests that temperatures between 30° and 85° F produced no effect, or affected merely to a slightly extent the composition of milk. However, temperatures over 90° F resulted a decrease in the milk-fat and solids-not-fat contents. In these experiments the total milk solids and protein content proved to be the lowest in July and August of the three species tested (i.e. Jersey, Guernsey and Holstein). The unfavourable effect of the warm weather could partly be eliminated by the change of the feed-rations. In the experiments of MERILAN—BOWER (cit. NESENI 1962) there was an increase in solids-not-fat content at higher temperature, whereas there was a decrease in it between —12 ° and —15 °C. According to LEGATES (cit. NESENI 1962) the seasonal and climatic influences could hardly be distinguished from the effects of the periods of lactation and nutrition. NESENI (1962) has found a low solids-not-fat content at the beginning of the year, higher values were observed in summer and the maximal amount was measured in October and November. It became, however, considerably less in December. In the course of his detailed investigations, CHALMERS (cit. NESENI 1962) observed a lower solids-not-fat content (8.69 per cent) from August to January, as compared to the period from February to July (8.74 per cent). Similar results were obtained by EDWARDS (cit. NESENI 1962) as well. BAILEY (cit. WAITE 1956) emphasizes that the winter period in Great Britain, especially February and March, results a low level of the dry matter content of the milk. Significant increase is resulted by the early grazing in summer.

According to TIHOMIROVA's (1961) trials the dry matter of the milk, including the protein and casein content, remains virtually constant in case of standard feeding both in winter and summer periods. The protein content of milk was measured as the lowest in April and July by KIERMEIER—RENNER (1960). The authors found the highest value in November and December. ALEXANDER—LEECH (1960) noted 0.13 per cent increase in the solids-not-fat content in spring as compared to the winter average value. The seasonal effect was of lower importance on the solids-not-fat content as compared to the milk-fat content as it was revealed by KÄSTLI (1956). KUGENEV—MEDVEDEVA (1961) state that the protein content has not changed significantly by the changing of seasons.

There are some discrepancies in the literature with respect to the effect of seasons on the solids-not-fat content and protein content of the milk. The seasonal and climatic influences seem to be resulted by the different nutrition of each period. The accurate evaluation of the experimental data is hindered by the fact that large-scale experiments do not make possible to segregate the seasonal and climatic effects on the one hand, and the nutritional influences on the other. It is another disturbing circumstance that the cows, for the most part, calve in late-winter and early spring.

Evaluating the problem on physiological aspects, it is rather probable that the lowest level of milk-protein occurs, in the countries of temperate zone, in April, July and August. Namely, the animals supplied with lesser and less varied feeding at the end of winter, are running short of their reserves which has an effect on the protein content of the milk, too. On the other hand, the metabolism of the animals become, especially under our conditions, more moderate due to the broiling and droughty heat in August. All these result a definite depression of the organic functions, blocking the synthesis of the milk itself. The reductional effect of the hot weather on the milk protein was also revealed by the authors mentioned above. It is worth mentioning that several workers attribute the different levels of milk-protein and casein observed in different seasons mainly to nutritional effects.

The values of protein and casein content of milk observed during some seasons are peresented as follows.

Material and Method

The experiments were partly performed on the livestock of 50 per cent Jersey blooded populations of Pécs, Városföld, Fertőd and Bábolna, respectively (i.e. 50 per cent Jersey blooded first and second generation derived partly from the bred in Hungary Hungarian spotted × Danish Jersey crosses); on the 25 per cent Jersey blooded ones of Mezőhegyes and Bábolna (R = 25 per cent Jersey blooded progeny of the Hungarian spotted cows and Hungarian spotted × Jersey F_1 bulls) and, finally, on the Hungarian spotted populations of Sárvár, Városföld, Mezőhegyes and Fertőd, respectively.

The protein content of milk was determined by the formoltitration of Schultz and the casein content — by the method of Inichow. During the period of investigations there was an extreme drought. It resulted an increase in yield of the rough fodder especially, which had a negative influence on both the consistency of milk and the milk production of crossed livestock.

To evaluate properly the interrelationship existing collectively and severally between the seasonal and lactational periods, the lactation of 10 months was divided into three periods. The order of each group was as follows: 1st, 2-nd and 3rd; 4th, 5th, 6th and 7th; 8th, 9th and 10th month of lactation. The mean values of the milk-protein and casein in per cent were of the same order. On the basis of this scheme six groups were set up according to the arrangement in winter or summer periods. In this paper there are presented the differences in protein and casein per cent between the winter and summer lactation periods. There were compared the milk protein and casein contents in the winter and summer periods of lactation of cows calved in the same years. Generally, there were more cows tested, calved in winter than in summer.

Results

The results estimated are summarized in Tables 1 and 2. It can be seen from the Table 1 that there was a significant difference in the protein content of milk produced by the 50 per cent Jersey blooded livestock of Pécs, Városföld and Fertőd, the 25 per cent Jersey blooded cows of Mezőhegyes and the Hungarian spotted population of Városföld, respectively, in winter and summer periods. In other cases the differences were insignificant.

According to the data shown in Table 2, the formation of the casein content was of similar character, although, there was no significant difference

Table 1

The protein content of milk of the crossbred and Hungarian spotted cows in the winter- and summer-periods of lactation (%)

Population		Lactation periods							
		Winter			Summer			Between the seasons	
		I–III	IV–VII	VIII–X	I–III	IV–VII	VIII–X	*	** P %
Pécs 50% Jersey	*n*:	70	13	46	12	78	45	1	4.1738< 5.00
	$\bar{x}$:	3.58	3.63	3.92	3.50	3.64	3.81		
Városföld 50% Jersey	*n*:	27	49	64	58	36	21	1	33.7264< 0.01
	$\bar{x}$:	3.66	3.81	4.12	3.50	3.78	3.76		
Fertőd 50% Jersey	*n*:	11	20	21	17	8	7	1	7.0499<0.01
	$\bar{x}$:	3.78	4.06	4.14	3.47	3.70	4.25		
Bábolna 50% Jersey	*n*:	14	16	3	5	3	16	1	0.2521 >20.00
	$\bar{x}$:	3.60	3.93	4.11	3.66	4.18	3.89		
Mezőhegyes 25% Jersey	*n*:	22	33	47	40	29	15	1	12.7163< 0.01
	$\bar{x}$:	3.61	3.70	3.90	3.51	3.68	3.66		
Bábolna 25% Jersey	*n*:	8	21	14	16	3	10	1	0.1210 >20.00
	$\bar{x}$:	3.31	3.49	3.65	3.39	3.38	3.55		
Városföld Hungarian-spotted	*n*:	19	63	48	49	5	20	1	5.9784< 0.10
	$\bar{x}$:	3.27	3.41	3.68	3.14	3.44	3.45		
Mezőhegyes Hungarian-spotted	*n*:	10	16	23	18	12	5	1	2.9130> 5.00
	$\bar{x}$:	3.33	3.41	3.63	3.29	3.30	3.56		
Fertőd Hungarian-spotted	*n*:	12	15	10	9	6	11	1	0.3620 >20.00
	$\bar{x}$:	3.16	3.34	3.45	3.17	3.21	3.53		

Notes: * = degree of freedom (variation); ** = "f" value.

in the casein content of milk produced by the 50 per cent Jersey blooded population of Pécs in the winter and summer periods. In general, the average protein and casein contents of milk of the half of the populations tested, proved to be greater in the course of the winter period, whilst that of the other half was nearly the same.

Table 2

The casein content of milk of the crossbred and Hungarian-spotted cows in the winter- and summer-periods of lactation (%)

Population		Lactation periods								
		Winter			Summer			Between the seasons		
		I–III	IV–VII	VIII–X	I–III	IV–VII	VIII–X	*	**	P%
Pécs 50% Jersey	n:	79	13	46	12	78	45	1	2.9510	> 5.00
	$\bar{x}$:	2.73	2.83	3.00	2.68	2.80	2.95			
Városföld	n:	27	49	64	58	36	21	1	18.0903	< 0.01
Jersey	$\bar{x}$:	2.86	2.95	3.21	2.74	2.95	2.98			
Fertőd	n:	11	20	21	17	8	7	1	7.6345	< 0.01
50% Jersey	$\bar{x}$:	2.90	3.22	3.32	2.67	2.89	3.40			
Bábolna	n:	14	16	3	5	3	16	1	0.8583	>20.00
50% Jersey	$\bar{x}$:	2.78	3.04	3.15	2.82	2.86	3.07			
Mezőhegyes	n:	22	33	47	40	29	15	1	4.0980	< 5.00
25% Jersey	$\bar{x}$:	2.77	2.86	3.05	2.74	2.89	2.90			
Bábolna	n:	8	21	14	16	3	10	1	1.3146	>20.00
25% Jersey	$\bar{x}$:	2.56	2.76	2.97	2.63	2.59	2.87			
Városföld	n:	19	63	48	49	5	20	1	12.9333	< 0.01
Hungarian-spotted	$\bar{x}$:	2.49	2.66	2.89	2.42	2.53	2.69			
Mezőhegyes	n:	10	16	23	18	12	5	1	3.9294	> 5.00
Hungarian-spotted	$\bar{x}$:	2.55	2.63	2.78	2.52	2.51	2.69			
Fertőd	n:	12	15	10	9	6	11	1	0.4566	>20.00
Hungarian-spotted	$\bar{x}$:	2.43	2.58	2.68	2.45	2.50	2.77			

Note: * = degree of freedom (variation); ** = "f" value

Conclusion

It can be established that the effect of the seasons (winter and summer) on the milk protein and casein content is not unambiguous. There are contradictory statements of the literature being reflected in the investigations on the changing influences of the seasons on the milk composition. The conjugate effects of several factors seem to be probable. Such factors may first be: the period of calvings, the pre-feeding for calving, the keeping and arrangement of the animals, the temperature of the environment in winter and summer, and the individual reactions of animals to all the influences of their immediate environment. Thus the amount of milk protein and casein content, as a quantitative characteristic may be altered, in the course of the seasons, by the influence of several factors.

In our investigations there were no significant differences found in the protein and casein content of milk produced in several seasons. The minor oumerical results of the percentile values in July and August were not nntable.

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GENETIC STUDIES IN SESAME

I. INHERITANCE OF SEED COAT COLOUR

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Considerable variability in seed coat colour was found in 26 varieties of sesame. The black colour was dominant over both brown and white, and the brown was dominant over white colour. The black and the white colours were controlled by a two factor pairs difference and gave a 9 : 3 : 3 : 1 ratio of black and dark grey, grey and white seed colours in the F_2. Likewise, the brown and the white colours were governed by two factor pairs giving an F_2 ratio of 9 : 3 : 3 : 1 of brown, light brown, grey and white seeds. The crosses between brown and black-seeded parents showed a monohybrid segregation. The factorial constitution of the parents is assumed to be as follows: black, AABB; brown, AAb^Rb^R; white, aabb.

Introduction

Sesame (*Sesamum orientale* L.) is a tropical and subtropical self-pollinated plant. It is the most important oil seed crop in Sudan (more than one million acres are devoted annually to this crop). The Sudanese varieties show a great deal of variability in seed colour (ranging from white to black). The white seeds have a better trade value since they are more qualified for confectionary and sweet-meats. Furthermore, it was reported by PAL (1934) and by PARTHASARATHY—KEDHARNATH (1949) that the oil of the white seeds is of a higher quality than that of the coloured ones.

The genic control of seed colour in sesame has been a matter in dispute. ABE (1919) was the first who established the dominance of black over both brown and white colours and that of brown over white. He claimed a two factor pairs difference between white and black as well as between white and brown colours. Similar findings were reported by NOHARA (1933). The two factor pairs difference between white and black colours was further confirmed by PATEL (1936) and by SIKKA—GUPTA (1947).

On the other hand, TESHIMA (1931) reported a three gene difference between white and black, and PAL (1934) claimed a single gene difference between the white colour and the darker colours of seeds. SIKKA—GUPTA (1947) indicated that the dark brown colour was completely dominant over the dirty white colour with a monohybrid segregation. Although they did not make crosses between black and brown-seeded types, the following factorial scheme was suggested: black C-B-dd, dark brown C-bbD- and white ccbbdd. To the best of our knowledge crosses between black and brown-seeded types were not studied before.

In Sudan, TAHIR (1959/60) attempted the purification of the local varieties by selection. The selections bred true for seed colour and Tahir concluded that the sesame seed impurity is rather of a physical than of a genetical nature. No genetical studies of seed colour were carried out before in Sudan.

The present work was undertaken to determine the inheritance of seed colour in the local varieties.

Material and Method

Seed samples of 26 varieties from different parts of Sudan were provided by W. M. Tahir (former plant breeder, Tozi Research Station). The percentages of the different seed colours in 0.5 g samples of each variety were determined. The 26 varieties were sown in 4 m rows (30×30 cm) in the Demonstration Farm, Faculty of Agriculture (Shambat) in 1959. Three varieties were chosen as parents on the basis of their seed colour, namely: *Hindi* (black-seeded), *Bara* (brown-seeded) and *Heavy White Kaffai* (white-seeded). These varieties will be referred to as K, B and W, respectively. Seeds from selfed plants of these varieties were planted in pots in the greenhouse.

Crosses were made between the three varieties in all possible combinations: WXK, WXB and BXK. Reciprocal crosses (using the darker seed coloured parent as female) were also made. More emphasis was put on the crosses BXK since they have not been studied before, although they are necessary for determining the factorial constitution of the parents.

The hybrid pods were collected separately and the identity of each pod was retained in the succeeding generations. The hybrid seeds were sown in pots.

The majority of the F_1 flowers were selfed (the flowers which escaped selfing were removed), and the seeds of each F_1 plant were collected separately. At this stage, it was possible to distinguish between the hybrid F_1 plants and those which resulted from selfing. The seeds of the hybrid F_1 plants showed the dominance of darker colour, while the seeds of the selfed plants showed the original light colour of the mother plant; and thus were discarded. The same procedure could not be applied to the reciprocal crosses because the darker colour would be retained on the F_1 plants irrespective of whether they have resulted from crossing or selfing. The work on the reciprocal crosses was thus terminated.

The selfed seeds of each F_1 plant were sown in one or more rows in the field. The spacing was 30×30 cm. The seeds of each F_2 plant were collected separately and their colour was recorded.

Results

1. *Survey of the local varieties*. The seed colour showed a high degree of variability both intra- and intervarietal. None of the varieties was homogeneous in seed colour (Table 1). It is clear that certain varieties exhibited a limited range of colours, while others showed a wider range. Heavy White Kaffai, Gerabin Light, Fung White, Mass Selection Early Resistant White and Quarein Late Light were considered of a white or creamy seed colour. The brown colour was dominating in Abu Zabad, Bara, Dala, Mafaza Light and Strang; while the black colour was dominating only in the variety Hindi.

2. *Inheritance of seed coat colour*. In all the crosses the colour of the hybrid seeds was similar to that of the female parent. This is due to the fact that

Table 1

The percentage of different seed colours in 0.5 g of seeds from each variety

Variety	Black %	Dark grey %	Brown %	Light brown %	Grey %	Creamy* %	White %
1 Abu Zabad			74.3	25.7			
2 Amartaba			11.3	13.7			75.0
3 Bara			75.1	24.9			
4 Baladi			59.8	17.8	15.5	6.9	
5 Cheparida				30.0	10.6	59.4	
6 Dala		12.5	76.1	11.4			
7 Fung white		1.5		9.8			88.7
8 Gedaref Selection		8.4		14.5	13.2	43.9	20.0
9 Gedaref type		5.6		27.1	17.9	28.3	21.1
10 Gerabin Light		2.0			16.6	17.4	64.0
11 Gidiem			2.0	25.8	3.9	68.3	
12 Goma		20.0	16.5	11.6	41.7	10.2	
13 Goma Agbash		32.2	22.3	27.5	7.4	5.8	4.8
14 Heavy Qul ennhal		16.6					83.4
15 Heavy Red		5.9	27.5	43.2		23.4	
16 Heavy White Kaffai			1.6	2.6	2.5		93.3
17 Hindi	85.6	5.2	5.6			3.6	
18 Light Kaffai		2.4	0.6	12.2		45.4	39.4
19 Mafaza Light			1.8	98.2			
20 Mass Sel. Early R. W.				14.1		85.9	
21 Medium Brown		2.5	34.5	48.4	5.4	9.2	
22 Naradei el Lebu			25.8	41.2	30.9	2.1	
23 Quarein Late Light			0.6	11.4		5.7	82.8
24 Strang		3.5	39.8	49.9		6.8	
25 Torit Selection		39.3		19.6	19.2	20.9	
26 Wad el Nail H. B.			32.7	26.9	20.4		

* Creamy is referred to commercially as white

the colour results from the deposition of pigments in the cells of the seed coat which is a maternal tissue (NOHARA 1933).

Invariably, the F_1 progenies were characterized by a dark seed coat which was similar to the male parent. In other words, the black and brown seed colours were dominant over white; and black was dominant over brown.

The type of segregation observed in the F_2 was as follows:

a) Crosses between white and black-seeded parents (WXK): The colours of the seeds born on the F_2 plants of this cross were classified into 4 phenotypic classes; black, dark grey, grey and white. The ratio was 9:3:3:1, respectively (Table 2).

b) Crosses between white and brown-seeded parents (WXB): The range of colours in the F_2 generation of these crosses was classified into 4 phenotypes, namely: brown, light brown, grey and white. The observed frequencies occurred in the ratio of 9:3:3:1, respectively (Table 3).

c) Crosses between brown and black-seeded parents (BXK): The F_2 seeds of this cross fell in two classes, namely, black and brown. The results presented in Tables 4 and 5 lead to the conclusion that there is only a monogenic difference between black and brown colours of seeds. Since X^2_s (Table 4) is not significant, each family can be assumed to be homogeneous and X^2_h (heterogeneity X^2) need not be calculated.

Table 2

Test of goodness of fit to the dihybrid ratio in the pooled progeny of five families of the cross WXK

Phenotype	Observed	Expected (9 : 3 : 3 : 1)	$(O-E)^2/E$
Black	229	211.50	1.4479
Dark grey	68	70.50	0.0887
Grey	64	70.50	0.5993
White	15	23.50	3.0745
Total	376	376.00	$X^2 = 5.2104$ $(P = 0.10-0.20)$

Table 3

Test of goodness of fit to the dihybrid ratio in the pooled progeny of five families of the cross WXB

Phenotype	Observed	Expected (9 : 3 : 3 : 1)	$(O-E)^2/E$
Brown	214	218.80	0.1057
Light brown	83	72.93	1.3904
Grey	70	72.93	0.1177
White	22	24.31	0.2199
Total	389	388.97	$X^2 = 1.8337$ $(P = 0.50-0.70)$

Table 4

Observed segregation of black and brown seed colours (BXK) and goodness of fit to the monogenic F_2 ratio in eight families

Family No.	Phenotype		X^2 (3 : 1)	P Value
	Black	Brown		
I	27	8	0.0856	0.70—0.80
II	129	36	0.8909	0.30—0.50
III	166	48	0.7538	0.30—0.50
IV	182	62	0.0217	0.80—0.90
V	166	50	0.3949	0.50—0.70
VI	116	39	0.0021	0.95—0.98
VII	499	165	0.0080	0.90—0.95
VIII	179	53	0.5746	0.30—0.50
Total	1464	461	2.7316	0.90—0.95

Table 5

The X^2 value of the pooled progeny of eight families of the cross BXK

Phenotype	Observed	Expected (3 : 1)	$(O-E)^2/E$
Black	1464	1443.75	0.2840
Brown	461	481.25	0.8520
Total	1925	1925.00	1.1360 (P = 0.20—0.50)

These results could be easily explained by assuming that the parents have the following factorial constitution: Black, AABB; Brown, AAb^Rb^R; White, aabb.

Discussion

The seed colour exhibited a great amount of variability both within and between varieties. It is generally known that the varieties of Western Sudan are characterized by brownish seeds, while those of Eastern Sudan (Fung and Gedaref) are of whitish seeds. The existing heterogeneity within varieties of either group is probably due to non-rigid selection practised by the growers. A breeding programme for the improvement of the colour standard of cultivated varieties would be possible through the understanding of the genetical behaviour of this character and the extent of natural cross-pollination. The latter aspect is under investigation by the senior author.

It is shown in the present work that the seed colour is a maternal character and exhibits delayed inheritance. The genetic constitution of the seed coat in the hybrid seed was similar to the genetic constitution of the mother plant, and thus exhibited the colour of the maternal parent. The segregation of genes controlling this character took place in the embryos of the seeds of the F_1 plants. Therefore, the dominance was manifested in this generation. The coats of seeds produced by the F_2 plants were similar in their genetic constitution to the F_2 plants and thus were segregated.

The F_2 segregation revealed that the grey seed colour was common in the crosses white x black and white x brown. This suggested the existence of a basic factor for both black and brown seed colours. This factor was designated with A. The difference between the two colours was considered as due to a second factor which was designated with B for the black colour and with b^R for the brown colour. The complementary action of A and B gave the black colour, while that of A and b^R resulted in the brown colour. B was found to be dominant over b^R giving the monohybrid ratio of 3 : 1 in the cross brown x black. The white seed colour was considered to be of the constitution aabb, giving a segregation ratio of 9:3:3:1 when crossed with either black or brown. The factor A was dominant over the factor a, while both B and b^R were dominant over b in a multiple allelic series.

On the basis of the present findings, the white seed colour (being double recessive) could be easily selected and maintained in the pure form. The development of a genetically uniform white-seeded variety could be achieved through mass selection or single plant selection.

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PEROXIDASE AND CATALASE ENZYME ACTIVITIES IN PEA SEEDS

By

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Searching reasons for germinative inability in the insufficient activity of enzymes catalyzing the physiological processes of germination, present paper deals with the relation of percentage germination to the catalase and peroxidase activities of seeds.

Introduction

Pea seeds are known to be able to germinate as soon as they have ripened. In spite of this fact certain unfavourable growing conditions (rainy seasons) a high percentage of pea seeds incapable of germination may occur. This unusual reduction of percentage germination (60—65 per cent instead of 90—95 per cent) has serious economic consequences in seed production, since germinative ability is one of the most important standard values of seeds produced.

Germinative inability occurring in pea seeds can be traced to physiological causes — apart from the phenomenon of hard, impermeable seed-coat. Seeds contain nutrients reserved in such high quantity as ensuring growth for heterotrophic seedlings as long as they are not capable of independent assimilation. Consequently, a re-examination of sufficient activities of enzymes catalyzing various co-ordinated physiological processes is above all justified from the point of view of germination inability. Earlier investigations showed mobilization of reserved nutrients taking place even in swollen but not germinating pea seeds. Accordingly, no difference in hydrolase enzyme activities (amylase, protease) can be found between germinating and non-germinating pea seeds.

During the process of germination hydrolytic decomposition of reserve nutrients following the swelling of the seed creates the inner conditions required for transforming the embryo into seedling. Hydrolytes are partly the initial materials of synthetic processes taking place in the embryo, partly the substrates of respiration providing the necessary energy. The rapid increase of respiration observed at the beginning of water uptake by the seed (10—12 hours) is in connection with the enzymatic system — existing already in the dry seed — getting gradually into an active state; however, as soon as synthetic processes — first of all protein syntheses — begin to take place in the embryo, a new respiration capacity is added to the performed respiration capacity (FARKAS 1968). On the basis of the above observations, germinative inability of the seed may be traced back to the low activity level of one of the enzymes involved in the process of respiration.

Terminal oxidation in higher plants takes place mainly through the electron transport chain tied up with the mitochondria, when cytochrome oxidase is the ultimate oxidase. Other terminal oxidases — soluble oxido-reductive enzyme systems — as e.g. peroxidase, polyphenol-oxidase, ascorbic acid-oxidase, are also potentially present in the tissues. However, these soluble oxidases appear as terminal oxidases only when desorganization occurs in the tissues.

Theoretically catalases may also be taken into account as terminal oxidases, since with a low hydrogen peroxid concentration they perform a peroxidative function. Some authors suggest a correlation between peroxidase and catalase enzyme activities and germinative ability. In the presence of peroxidase BRÜCHER (1948) found an indication of the viability of the seed. According to LJUBCHENKO (1959) catalase activity shows the life functions and germinative ability of seeds. The same was pointed out earlier by CROCKER—HARRINGTON (1918). RALL (1960) decreased germinative ability in maize grains by treating them with heat and found a considerable degree of parallel reduction in the catalase activity. On the contrary, others consider a high peroxidase activity rather than catalase activity as being characteristic of the germinative ability of seeds (SZALAI—FRENYÓ 1962). On the basis of results obtained by examining the seeds of 15 plants MORALES (1965) suggested dehydrogenase activity as being a better indicator of germinative ability than peroxidase activity.

With the above data taken into consideration the following questions seemed to require a thorough examination: 1. are catalase and peroxidase enzyme activities in connection with percentage germination? and 2. is there any difference in enzyme activity between germinating and non-germinating pea seeds?

Material and Method

Activities of catalase and peroxidase enzymes were studied in ground one year old air-dried pea samples of various germination percentage as well as in germinating and non-germinating seeds.

Percentage germination was determined by averaging the number of seeds having germinated in 8 days at room temperature out of 4 × 100 pea seeds placed between wet filter paper layers in four replications.

Catalase activity is determined on the basis of a decomposing effect exercised by the enzyme on the hydrogen peroxide; it is demonstrated by the following equation and applied in the gasometric apparatus included in the Hungarian patent No. FE-542.

$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

In the course of the determination pea seeds cut into two halves are treated with a freshly made hydrogen peroxide solution of 1 per cent concentration. The amount of oxygen released as a consequence of the catalase activity can be directly read from the calibrated tube of the apparatus. The figure expressing the catalase activity shows the degree of the enzyme activity. Catalase activity number = the mm^3 amount of oxygen released in one minute.

In presence of hydrogen peroxide the peroxidase enzyme oxidates hydrogen donors (AH_2) according to the following equation.

$$AH_2 + H_2O_2 \xrightarrow{\text{peroxidase}} 2H_2O + A$$

Transformation of pyrogallol (AH_2) into purpurogallin (A) was used to measure the activity of the peroxidase enzyme (Beloserski—Proskurjakov 1956). From the ground seed with a 1 per cent solution of $NaHCO_3$ a 2 per cent suspension was prepared, then — after having been shaken for an hour — filtered and 5 ml quantity of filtrate was incubated for 5 minutes at room temperature with 2 ml substrate solution added to it. The substrate solution consisted of a 5 per cent diluted solution of freshly made pyrogallol and a 5 per cent diluted solution of freshly made hydrogen peroxide, mixed in a ratio of 10 : 1, then left to stand for 25 minutes. The time of incubation was clocked; after it had passed the enzyme activity was stopped with 0.1 ml sulphuric acid of 10 per cent concentration, and purpurogallin produced in the meantime shaken three times with ether. The etheric phases were combined and — with pure ether added — completed to a final volume of 20 ml. The yellow solution was tested in Pulfrich's photometer against pure ether, with an S 45 colour filter applied. Purpurogallin concentration corresponding to the extinctions read was shown by the earlier plotted concentration—extinction curve.

The peroxidase activity-number was given by the mg quantities of purpurogallin produced by 1 g air-dried pea flour in 5 minutes. That is, peroxidase activity-number determined at the time of germination is the mg amount of purpurogallin produced per 1 g dry matter in 2 minutes.

Table 1

Catalase activity in pea samples with different germinative ability (r = correlation coefficient)

Variety	Percentage germination (percentage of germinated seeds)	Percentage of non-germinated seeds	Catalase-activity number	r
Early Viktória	69	31	38.4	
of Ujmajor	77	23	16.9	
(Pisum sativum pachylobum)	89	11	47.1	
	91	9	27.4	
	93	7	33.1	+0.140
Petit Provencal	47	53	69.4	
(Pisum sativum pachylobum)	80	20	71.7	
	90	10	69.3	
				+0.019
Victory Freezer	54	46	56.1	
(Pisum sativum quadratum)	61	39	92.4	
	65	35	81.5	
	71	29	71.3	
	74	26	62.3	
				—0.074

Results

Germinative ability of dry seeds can be determined only after germination. Thus enzyme activities of germinating and non-germinating dry seeds cannot be separately determined for the purpose of comparison. Since it was germinative ability and inability as developed under natural conditions that were to be studied from an enzymatic point of view, artificial deterioration of germinative ability could not be taken into account. For this very reason only one way seemed to be suitable to study the correlation between catalase and peroxidase activities on one hand, and germinative ability or inability on the other: to measure enzyme activities in pea samples of different germination percentage. Percentage germination expresses the numerical relation of germinating and non-germinating seeds. If correlation between germinative ability and enzyme activities is a close one, in seed samples with very low germinative ability the level of enzyme activity must be different from that in samples showing high germination percentage, due to the higher number of non-germinating seeds.

Table 2

Peroxidase activity in pea samples with different germinative ability
(r = correlation coefficient)

Variety	Percentage germination (germinated seeds)	Percentage of non-germinated seeds	Peroxidase-activity number	r
Victory Freezer	54	46	13.0	
(Pisum sativum quadratum)	61	39	13.7	
	65	35	11.0	
	71	29	10.8	
	74	26	10.5	
				−0.874
Early Viktória	56	44	16.2	
of Ujmajor	61	39	14.1	
(Pisum sativum pachylobum)	69	31	14.8	
	75	25	14.4	
	92	8	14.3	
				−0.550
Petit Provençal	47	53	9.5	
(Pisum sativum pachylobum)	80	20	12.4	
	90	10	13.0	
				+0.998

Table 1 shows the catalase while Table 2 the peroxidase enzyme activities of the three varieties examined, in function of changes in the germinative ability. Correlation coefficients included in the Tables represent the quality of the relation.

The results of measuring and correlation coefficients calculated from them show no relationship between percentage germination and catalase activity measured in dry seeds. On the other hand, a medium close correlation was found between peroxidase activity and germinative ability; however, differences between varieties — now linear, now inverse correlation found — suggest, that peroxidase activity in dry seeds is not the direct cause and inducing factor of changes in germinative ability.

Catalase activity displayed by germinating and non-germinating seeds when germinated is included in Table 3, while peroxidase activity in Table 4.

Table 3

Changes in catalase activity in the course of germination

Variety	Period of germination, number of days	Catalase-activity number	
		germinating seeds	non-germinating seeds
Petit Provençal *(Pisum sativum pachylobum)*	2	200	50
	3	480	150
	4	710	210
	5	440	100
	6	410	110
Early Viktória of Ujmajor *(Pisum sativum pachylobum)*	2	120	80
	3	445	105
	4	450	110
	5	580	98
	6	340	110
Victory Freezer *(Pisum sativum quadratum)*	2	210	50
	3	490	180
	4	500	200
	5	315	110
	6	290	112
Lincoln *(Pisum sativum quadratum)*	2	150	90
	3	400	205
	4	385	190
	5	380	140
	6	250	110

Table 4

Changes in peroxidase activity in the course of germination (k = peroxidase activity ratio of germinating and non-germinating seeds)

Variety	Period of germination, number of days	Peroxidase-activity number		$\frac{k}{n}$
		germinating seeds (k)	non-germinating seeds (n)	
Petit Provençal *(Pisum sativum pachylobum)*	1	35	48	0.7
	2	36	38	
	3	48	49	
	4	56	54	
	5	67	61	1.1
Early Viktória of Ujmajor *(Pisum sativum pachylobum)*	1	22	49	0.4
	2	28	41	
	3	45	42	
	4	51	45	
	5	60	50	1.2
Victory Freezer *(Pisum sativum quadratum)*	1	61	65	0.9
	2	45	50	
	3	49	66	
	4	50	55	
	5	53	41	1.2

With all varieties examined germinating seeds showed higher catalase actviity than non-germinating ones did in the course of germination.

On the first day of germination, when all pea seeds have already swollen, peroxidase activity is higher in non-germinating seeds than in germinating ones irrespective of the variety. However, on the fifth day of germination the situation is the other way round with all varieties: peroxidase activity of germinating seeds surpasses that of non-germinating ones. This fact is represented also by the enzyme activity ratio of germinating and non-germinating seeds, which is an average of 0.6 on the first, and rises to 1.2 by the fifth day of germination.

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OROBANCHE AEGYPTIACA PERS. INFECTION, ECONOMIC LOSS OF THE HOSTS, AND CONTROL OF THE PARASITE

By

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Orobanche infection affects all parts of host plants as evident from the reduction in the dry weight of both shoot and root. Yield drop is followed by a degradation in the quality of the fruits of hosts. Among the chemicals used for the control of this parasite, iso-amyl alcohol, trichloro-acetic acid and 2.4-D (Na-salt) were found to be quite efficacious. In the case of root crops a certain deformation in the host product was evident. In acute cases the chemicals were found to be toxic to the root crops.

Introduction

Orobanche aegyptiaca Pers., a total root parasite, is a serious problem in the production of cabbage, cauliflower, brinjal and tomato. Host—parasite contact cannot be easily detected until the parasite emerges out of the soil. The parasite shares the inorganic nutrients and water absorbed by the host plant from the soil, and robs the organic food synthetized by the host, which therefore, leads to low yield.

Several chemicals, namely: 1,3-dichloropropane, CIPC, MCPB, Urea, α-napthalene-acetic acid, etc. have been suggested to be effective in *Orobanche* control (ANAND 1953, ADDY 1956, IZARD *et al.* 1958, BAKR *et al.* 1958). WERNECK (1940) proposed manuring of P_2O_5 for controlling this parasite (weed).

The present study deals with the effect of *Orobanche aegyptiaca* infection on the growth of five hosts. An attempt has also been made to assess the loss of crops due to the *Orobanche* infection in the field. Some chemicals have also been applied in order to control this parasite.

Material and Method

Field experiments with five crops: *Solanum melongena* L., *Lycopersicum esculentum* Mill., *Brassica campestris* L. var. *sarson.* Prain, *Raphanus sativus* L. and *Brassica campestris* var. *rapa* were conducted in the vicinity of the Banaras Hindu University campus. Two fairly identical fields were chosen for each crop, leaving one as control. The other was artificially infected with *Orobanche aegyptiaca. Orobanche* seeds were spread in the field in January when the host plants were about two months old. The parasite was visible above the ground within a fortnight.

Growth of crop and parasite was studied at various stages after *Orobanche* emergence. Growth was recorded in terms of both root weight and shoot weight of host under healthy and diseased conditions. The same was due to parasites. The yields were later recorded to estimate the loss caused by *Orobanche* infection.

Chemicals, like 2,4-D (Na-salt), MH, $CuSO_4$, TCA (trichloro-acetic acid), and iso-amyl alcohol, in 1% solution, were sprayed in the ground around *Orobanche* plants at intervals of 5, 15, and 30 days after germination. Effect of chemicals was assessed by population count of parasite per sq. meter.

All results were subjected to statistical analysis.

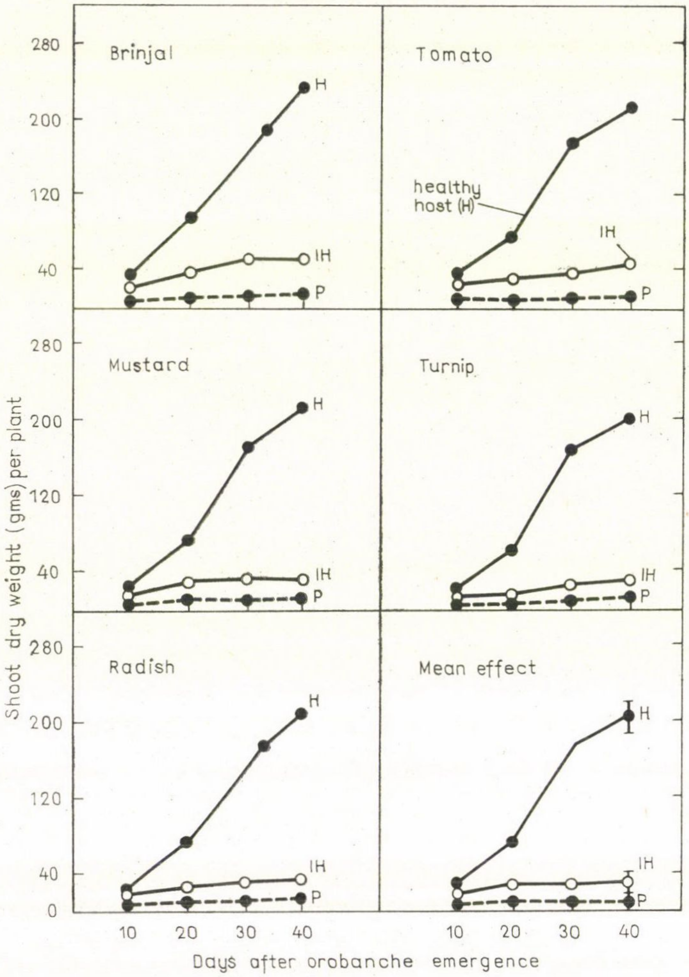

Fig. 1. Effect of *Orobanche* infection on the growth of shoots of host and parasite. Bars in the 'mean effect' represent critical differences at 5% level. (H) — healthy host; (I) — infected host; (P) — parasite

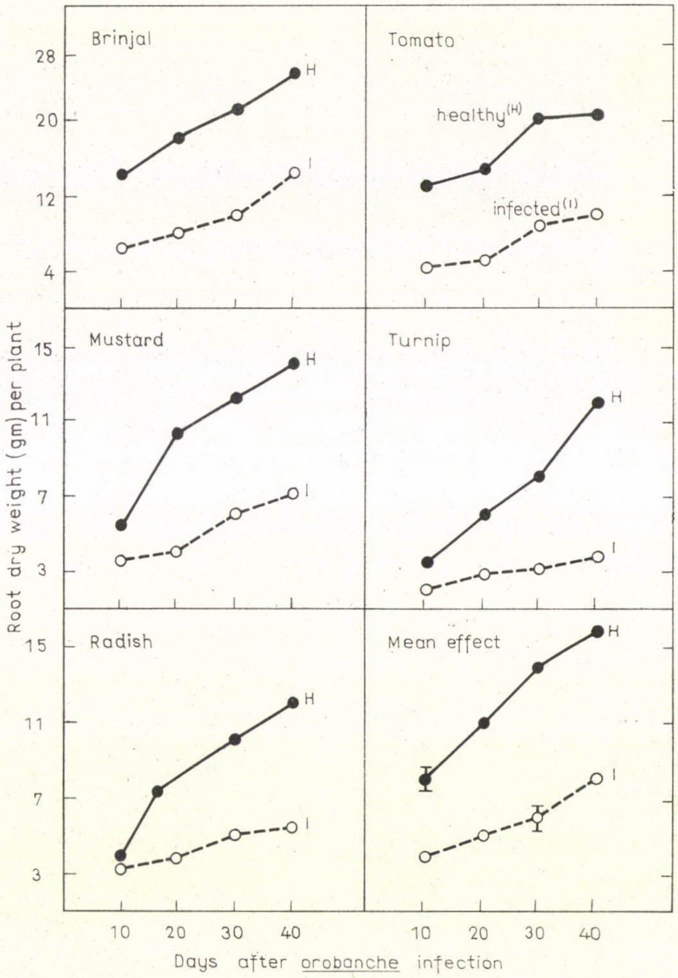

Fig. 2. Effect of *Orobanche* infection on the dry weight of host roots. Bars in the 'mean effect' represent critical differences at 5% level. (H) — healthy host; (I) — infected host

Results

Results persented in Fig. 1 and Fig. 2 show the effect of *Orobanche* infection on the dry matter content of the host shoot, host root and the parasite. It was found that the dry weights of healthy hosts (shoot and root) increased with age. On the other hand, dry matter content of the parasite was not proportionately affected. The dry weights of *Orobanche* infected hosts also increased with age but were reduced, sometimes as low as 20% of the healthy shoot and 50% of healthy root.

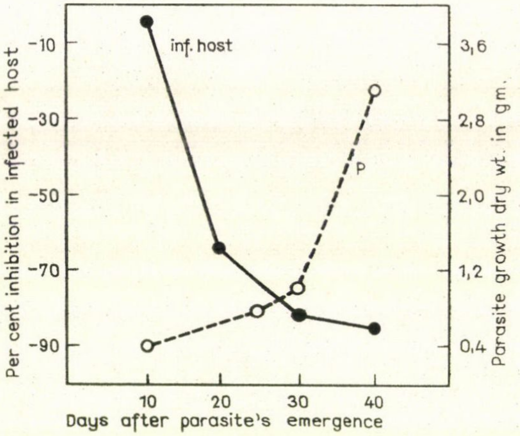

Fig. 3. Growth of *Orobanche* at the cost of host

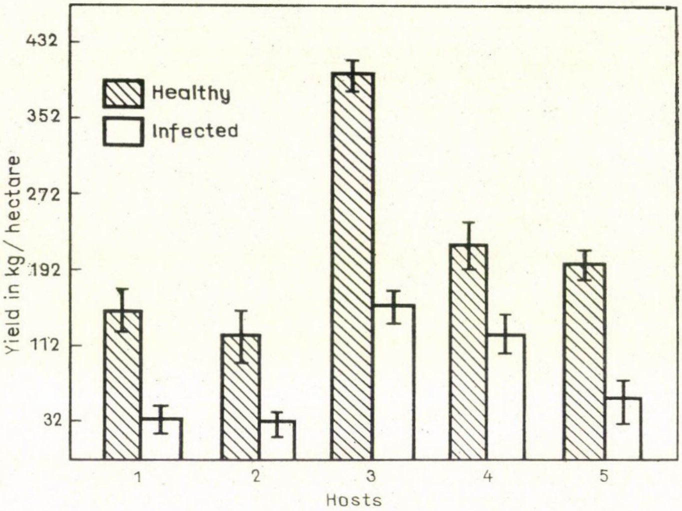

Fig. 4. Effect of *Orobanche* infection on the yield of host plants. Bars represent critical differences at 5% level. (1) — *Solanum melongena* L., (2) — *Lycopersicum esculantum* Mill., (3) — *Brassica campestris* L., (4) — *Raphanus sativus* L., (5) — *Brassica campestris* var. rapa.

The growth of the parasite was found to be inversely related to the growth of host plants (Fig. 3). Correlation study (Fig. 5) between the degree of growth inhibition in host and that of growth stimulation in parasite has revealed that they are positively correlated (r = +0.7). It is evident that the parasite robs nourishment from the host rendering the latter increasingly deficient in food, which results in poor growth and yield.

To observe further the economic loss of the infected host plant, Fig. 4 and Figs 1 and 2 have been presented. *Orobanche* infection has invariably

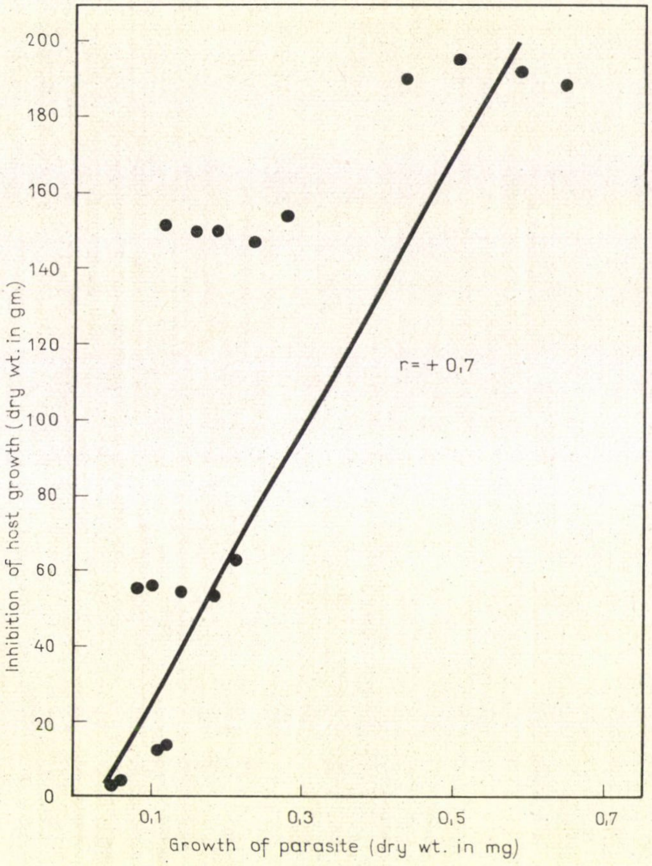

Fig. 5. Correlation between host growth and parasite growth. Correlation coefficient (r) = = +0.7

reduced the total yield of the vegetables found in association with it. Reduction in the yield was found to be more in the case of root crops (*Raphanus sativus* 54% and *Brassica campestris* var. *rapa* 48%) than the fruit vegetables (*Solanum melongena* 25%), *Lycopersicum esculantum* 39%) or the oil seed crop (*Brassica campestris* var. *sarson* Prain 32%).

Results of relative effect of various chemicals on the control of *Orobanche* have been presented in Fig. 6. It shows that out of the five chemicals used, 2.4-D (Na-salt), TCA and iso-amyl alcohol proved to be more efficient in 15% concentration, and competely checked the *Orobanche* growth when two to three sprays were applied. On the other hand, maleic hydrazine (MH) and copper sulphate ($CuSO_4$) gave partial control of the parasite in 1% concentration.

The degree of *Orobanche* control for fruit vegetables like *Solanum melongena*, was recorded to be approximately 66.66% by iso-amyl acohol; 75% by 2.4-D, 33.33% by MH; and 25% by $CuSO_4$. For the root crop like *Raphanus sativus*, percentages of control provided by the single spray of chemicals on the 5th day after emergence were 71.40% by TCA, 62.50% by iso-amyl alcohol and 77.77% by 2.4-D. The root crops appeared to be somewhat susceptible to these sprays and they gradually withered and died. The fruit vegetables like *Solanum melongena* and *Lycopersicum esculentum* and the oil seed crop, *Brassica campestris* var. *sarson*, Prain were not adversely affected by the chemicals.

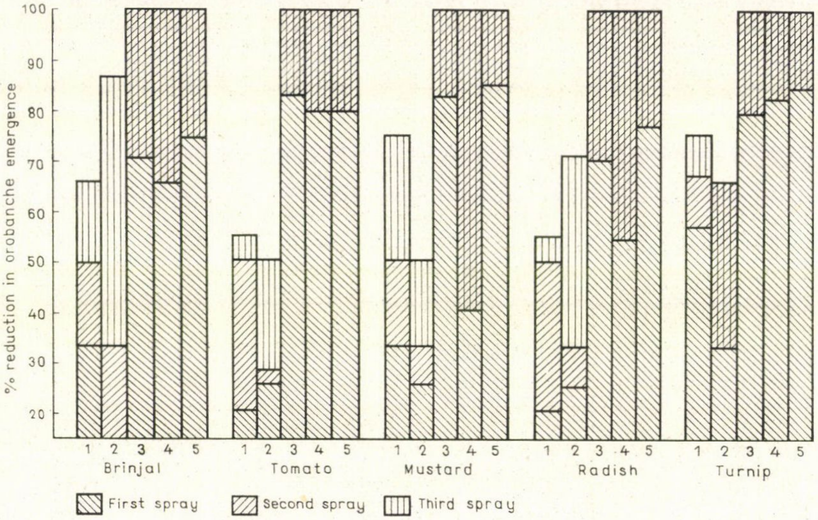

Fig. 6. Relative effects of various chemicals (1%) on the control of *Orobanche*. (1) — MH; (2) — $CuSO_4$; (3) — TCA; (4) — iso-amyl alcohol; (5) — 2,4-D (Na-salt)

Discussion

Results presented in the foregoing pages have brought light to the growth of *Orobanche* at the cost of the host. Deleterious effects of *Orobanche* infection were evident in all the parts of host plants. The dry weight of both shoot and root was reduced significantly following infection. Roots were more damaged.

The parasite, by means of its haustoria, consistently exhausts the host plant. ZAHRAN (1958) explained this on the basis of translocation of metabolites from the host to the parasite which eventually results in a weak host. KADRY *et al.* (1960) indicated that the physiological processes of the host, particularly assimilation, might be affected by this exhaustion. Indirect effect of mineral deficiency may also results in an ultimate loss in yield if the mineral supply of soil is limited.

Loss in yield is one of the striking features of *Orobanche* infection. No economic use of *Orobanche aegyptiaca* has been found so far. *Orobanche* infection affects all parts of host plant. Fruits of brinjal and tomato and the underground parts of radish and turnip are all subjected to reduction both in weight and quality. Yield drop has been reported by many other workers (WERNECK 1940). The constant robbing of organic food by the parasite leaves the host in a rickety stage with only a few flowers, which bear less number of fruits with reduced size and weight. Even the quality of the fruit is impaired. Similar effects were reported by EVANS (1962) and MALIK (1963) stating the depression in the healthy growth of plants in many other host species.

Several chemicals have been tried to control this parasite. Among them trichloro-acetic acid, iso-amyl alcohol and 2.4-D (Na-salt) were found to be quite efficient. Application of chemicals, as a possible control has been recommended by several workers (ANAND 1953, PEREZ 1956, ADDY 1956, WILHELM 1958, RACOVITA 1959 and MALIK 1963). Results of the present study indicate that iso-amyl alcohol and trichloro-acetic acid in addition to 2.4-D can efficiently control *Orobanche* growth. In many cases, root crops like radish and turnip had bad effects leading to deformed products, and in acute cases the host may even get withered and dry out due to the toxicity of chemicals. TOSIC (1958) also reported similar toxic effects of TCA, $CuSO_4$ and 2.4-D on root crops and *Orobanche*. Fruit vegetables and mustard, in contrary, remained unaffected.

Conclusions

It was found that *Orobanche* infection reduces the host crops both in quality and quantity. Further, iso-amyl alcohol, trichloro-acetic acid and 2.4-D (Na-Salt) seemed to be effective chemicals in controlling this parasite. On the other hand, $CuSO_4$ and high doses of trichloro-acetic acid, 2.4-D (Na-salt) and MH were found to be toxic to host crops.

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EFFECT OF NITROGEN ON YIELD AND MINERAL MATTER CONTENT IN TRITICALE

By

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The effect of one-sidedly applied and increasing doses of nitrogen fertilization on the macro- and microelement content and yield of Triticale No. 64 was studied. The examinations showed the following: Increasing doses of nitrogen fertilizer applied one-sidedly increased reliably the N, Mn and Mo content while decreased Ca and Zn in the Triticale grains. P, K, Mg, Fe and Cu contents of grains were not affected by the nitrogen fertilization. Triticale stems reacted to nitrogen fertilization only with their Mo and K contents: Mo content was reliably reduced while K increased by it. Under the influence of nitrogen fertilization the grain and straw yields of Triticale reliably increased resulting in a growing amount of microelements taken out of the soil.

Introduction

In addition to a number of environmental factors affecting the plants, crop production is greatly influenced by the optimum degree of nutrient supply. Therefore in fertilizers applied all nutrients should possibly be available for the plants. Namely, both abundance and deficiency of any nutrient may disturb the natural balance of nutrients and lead to nutritive troubles. In this case the metabolism of plants changes, involving in most cases a deficiency in other elements too, and even if the symptoms of hunger have not yet been shown by the plant, the state of a hidden hunger already exists.

Present investigations were aimed at studying the effect of one-sided nitrogen fertilization on the amount of grain and straw yields in Triticale and examining changes which occurred in the mineral matter content.

Results of investigations give, at the same time, information on the major mineral matters contained in Triticale.

Material and Method

The experiment aimed at studying the yield increasing effect of nitrogen fertilization was started in the autumn of 1968 at the Kisfái station of the Agricultural Research Institute with the Triticale No. 64 indicator plant laid out in 5 × 5 Latin square design on a sand covered soil. The size of the plots was 3×4.8 m $= 14.4$ m^2; treatments were the following, applying pétisó (ammonium nitrate) in 25 per cent concentration: 1) ø-, 2) 35-, 3) 70-, 4) 140-, 5) 280 kg/ha active agent N.

The preceding crop of the experimental area was tomato treated with farmyard manure (200 q/ha). Nitrogen fertilizer was therefore applied as top-dressing on 1st March 1969. Sowing was performed with 100 kg/yoke seeds used.

Samples were taken immediately after harvesting. A handful of plants per sheaf were taken at random from each plot.

Collected samples were dried in an exsiccator at a temperature not higher than 60 °C, then ground. Examinations were carried out with ground air-dried samples used. N, P and K contents were determined by a vitriolic destruction test with Sarkadi's method applied (Sarkadi—Krámer 1960). Samples for Ca, Mg and microelement determinations were prepared by a dry burning method used in the GDR (Bergmann 1964). Ca and Mg were determined from the stock solution by complexometric titration after Derderian's method (Derderian 1961). Fe, Mn, Cu and Zn were examined with a polarograph; Zn and Cu in a 2 mol NH_3 medium with saturated Na_2SO_3 present, while Fe in an alkaline trietanole-amine medium (Brezina—Zuman 1956). Mn was determined with Bolshakov's method (1964). In the above stock solution molybdenum was colorimetrically examined after Tölgyesi's method (1969). Plant samples from each plot were examined, and statistical evaluations carried out after Sváb (1967).

Results

The effect of nitrogen fertilization on the grain and straw yields of Triticale and on some properties of its flour is shown in Table 1.

Table 1

Effect of nitrogen on Triticale yields and on some properties of its flour

Treatment N kg/ha	Yield kg/plot		Thousand-grain-weight g	Ash %	Raw fibre %	Soluble protein %
	grain	straw				
0	1.34	2.56	35.37	2.28	2.70	0.46
35	2.16	4.40	38.86	2.25	2.70	0.46
70	2.82	5.66	39.08	2.32	2.60	0.46
140	3.36	7.10	41.46	2.40	2.50	0.49
280	4.36	7.88	41.28	2.34	2.60	0.52
l.s.d. 10%			3.70	—	—	—
l.s.d. 5%	1.00	1.50	—	—	—	—

According to the data of the table nitrogen fertilization exerted the greatest effect on the yield of the Triticale; it increased reliably the grain and straw yields of plots. (In the table calculations were made with plot yields only, as the plots were of very small area, and with data converted to yokes or hectares unreal results would possibly have been obtained.) Nitrogen fertilization resulted in reliable differences concerning thousand-grain-weight in Triticale as well.

Data did not show any influence exerted by the fertilization in question on ash and raw fibre contents. A slight increase could be observed in the soluble

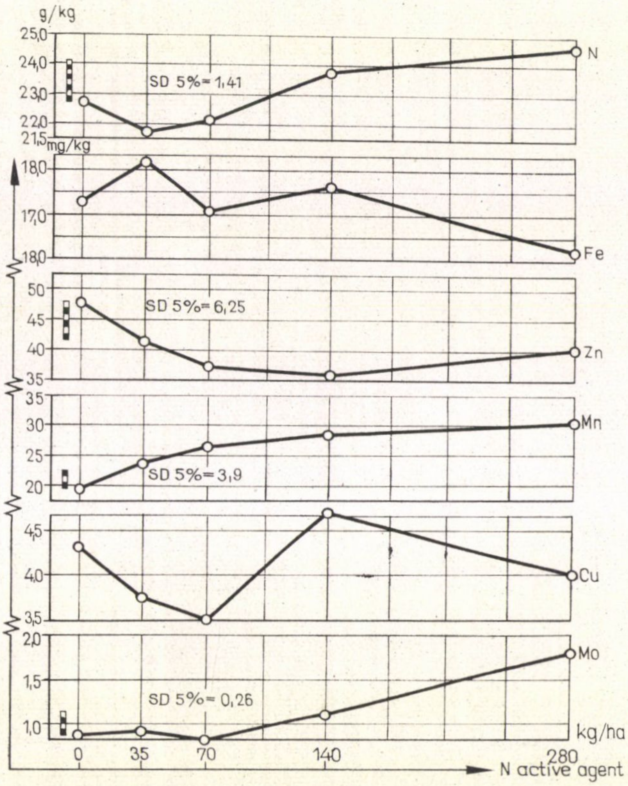

Fig. 1. Changes of microelement content in the grain yield of Triticale No. 64 as a reaction to various doses of N-fertilizer

protein content of Triticale grains as a response to increased doses of nitrogen fertilization. This was, however, only a tendency, since no reliable differences could be found between the treatments.

The effect of nitrogen fertilization on the major macro- and microelements contained in Triticale are shown by Table 2. Results of investigations display that it was the nitrogen content of grains that the most conspicuous effect was exerted on by the one-sided nitrogen fertilization; latter increased the N content of grains reliably. Such effect of nitrogen fertilization is today generally known in most plants.

Ca contents of grains were contrarily influenced by the nitrogen — even if only in an indirect way. According to the data of investigations with increased doses of nitrogen the Ca content of grains reliably decreased. Phosphorus, potassium and magnesium contents of grains were not influenced by the nitrogen fertilization, as no changes occurred in the macroelement contents of stalks either, with the exception of K.

Table 2

Effect of nitrogen on major macro- and microelements contained in Triticale

Plant parts	Treatment N kg/ha	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Mo
		g/kg					mg/kg				
Grain	0	22.7	4.53	6.50	0.23	0.44	172.8	19.6	47.7	4.31	0.86
	35	21.7	4.60	6.20	0.22	0.50	181.5	23.6	41.5	3.76	0.91
	70	22.1	4.70	6.30	0.24	0.67	170.7	26.2	37.3	3.50	0.79
	140	23.7	4.76	6.40	0.17	0.49	176.1	28.5	37.1	4.72	1.10
	280	24.6	4.80	6.60	0.14	0.52	162.0	30.3	39.9	4.00	1.78
l.s.d.	0.1%	—	—	—	—	—	—	7.8	—	—	0.51
	1%	1.98	—	—	0.07	—	—	5.5	—	—	0.36
	5%	1.41	—	—	0.05	—	—	3.9	6.25	—	0.26
	10%	1.15	—	—	0.04	—	—	3.2	5.10	—	0.21
Stem	0	6.4	1.43	10.3	2.80	0.93	506.6	13.6	7.0	8.27	0.98
	35	7.3	1.75	11.8	3.00	1.10	366.5	16.8	7.5	8.96	0.57
	70	7.1	1.73	11.4	2.80	1.00	383.1	17.5	6.5	9.32	0.39
	140	7.3	1.85	12.9	2.82	1.00	394.2	17.5	5.9	8.96	0.29
	280	6.6	1.59	12.3	3.03	1.10	380.3	16.9	5.6	9.82	0.22
l.s.d.	0.1%	—	—	—	—	—	—	—	—	—	—
	1%	—	—	—	—	—	—	—	—	—	0.15
	5%	—	—	—	—	—	—	—	—	—	0.06
	10%	—	—	1.61	—	—	—	—	—	—	0.05

Note: Significant differences were only found at places shown by the table

According to the data of Table 2 mircoelement content of Triticale grains was much more reactive to nitrogen fertilization. With the exception of Fe and Cu nitrogen fertilizers caused changes in the amounts of all the other microelements examined.

Parallelly with an increase in the nitrogen content of grains unambiguous increase of manganese and molybdenum contents could be observed. This can be explained with the role played by manganese and molybdenum in protein formation. Manganese is known to play a manifold role in plant metabolism. Its presence is indispensable in protein formation too (Doby 1959, Girfanov—Rakhovskaya 1964, Majewski 1961, Vlasyuk 1962).

Molybdenum, on the other hand, is a component of the nitrate reductase enzyme. In its absence nitrate nitrogen accumulates in the plants and inhibits the protein synthesis (Farkas 1968, Majewski 1961, Minina 1963, Tisdale—Nelson 1966).

This is the explanation of manganese and molybdenum contents of Triticale grains increasing parallelly with the nitrogen content. Correlation calculation made of the data of investigation confirms what have been said.

A medium-close positive correlation was found between nitrogen and manganese contents of grains ($R = 0.40$). Data proved reliability at 5 per cent level of probability.

Correlation between nitrogen and molybdenum contents of grains is also medium-close ($R = 0.42$). Thus, increased doses of nitrogen fertilization obviously increased the manganese and molybdenum contents too, in addition to the nitrogen content of grains.

Increase in the manganese content of grains involved then an increased calcium content. DOBY (1959) and TÖLGYESI (1969) mention an antagonism existing between manganese and calcium. According to the data of our investigations there is a medium-close negative correlation ($R = 0.58$) between calcium and manganese. Data prove reliability at a 1 per cent level of probability.

Increased doses of nitrogen fertilizers did not cause reliable changes in the Fe content of grains. However, it is not so much an absolute amount of Fe that is important, as its relation to other elements. The ratio of iron to manganese is of high importance in the life processes of plants. No unanimous opinion exists, however, in literature concerning this often studied iron-manganese interaction.

SOMERS—SHIVE (1942) and TANAKA—NAVASEW (1966) suggest an ion antagonism based on reduction potential as existing between iron and manganese ions. On the other hand, BURGHARDT (1956) traced back the deficiency or surplus of iron and manganese to the processes of growth, assimilation and respiration. Deficiency of manganese cannot be caused by a surplus of iron.

According to TÖLGYESI (1969) iron and manganese contents of a plant cannot be — under natural conditions — in any connection with each other.

Data of our investigation showed that an increase in the manganese content — even if in an absolute sense it did not affect the iron content of Triticale grains — decreased the ratio of Fe to Mn.

With the increase in the manganese content of grains less and less iron fell to the unit content of Mn. In the present case trends in the Fe/Mn ratio were decisively influenced by the manganese content. According to TÖLGYESI (1969) the relation of iron and manganese is first of all a function of the manganese content.

When the effect of one-sidedly applied increased doses of nitrogen fertilizer on the Zn content of Triticale grains are studied, data show a reliable decrease in the Zn content of grains as caused by the nitrogen fertilization.

Cu has an important part in protein formation, as proved by our experiments where the protein content of grains increased under the influence of nitrogen fertilization. It did not seem, however, to affect the Cu content of the indicator plant.

Data of Table 2 show, further, that nitrogen fertilization had hardly any effect on the microelement content of Triticale stems, and among the macroelements only potassium was affected. Changes were caused only in the molybdenum content: it was just stems of plants given the largest (280 kg/ha) doses of nitrogen fertilizer that contained the lowest amount of molybdenum. In our opinion, this can be explained with the role played by molybdenum in the nitrate metabolism and protein synthesis. Changes caused by the nitrogen fertilization in the microelement content of Triticale grains are presented in Table 1.

As to the mineral matter content of Triticale grains it was not so much the macroelements as the microelements that were affected by the one-sided nitrogen fertilization. Under its influence amounts of certain microelements (Mn, Mo) increased, those of others (Fe, Cu) remained unchanged while the amount of Zn decreased. These changes caused by fertilization decisively influenced, in turn, the micro-nutrient content of the soil.

As a reaction to increased doses of nitrogen fertilization Triticale yields showed trends presented by Table 1. According to the data of the table nitrogen reliably increased the amounts of grain and straw yields.

By means of microelement analysis data amounts of micro-nutrients extracted per plot by the Triticale yields were calculated from the yield results; the respective data are included in Table 3.

Table 3 shows that even a 35 kg/ha dosis of N greatly increases the amount of microelements taken out of the soil. Under the influence of doses larger

Table 3

Amounts of microelements extracted from the soil under the influence of nitrogen fertilization
(mg/plot)

N kg/ha	Fe	Mn	Zn	Cu	M
0	1482.7	61.5	148.4	27.4	3.63
35	1892.7	119.9	215.5	44.6	4.52
70	2437.9	175.9	244.8	62.7	4.38
140	3368.3	227.1	302.9	79.0	5.62
280	3834.8	263.3	414.9	95.5	5.64
l.s.d. 5%	774.3	208.2	71.4	19.2	2.51

than that this process takes place, naturally, at a highly increased rate (Győry 1963).

The microelement extracting effect of fertilization raises the question of microelement supply, otherwise fertilization would gradually lead to the depletion of the micro-nutrient reserves of the soil. This applies especially to sandy soils.

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ON THE ROLE OF LEAF AREA AND PHOTOSYNTHETIC PRODUCTIVITY IN DRY MATTER ACCUMULATION OF THE RICE PLANT

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From the point of view of photosynthesis and dry matter production, two main phases of vegetative period of the rice plant can be distinguished: phase of high leaf expansion and phase of high photosynthetic productivity. A great part of dry matter constituting rice grain is accumulated during the second phase. Nitrogen must be used to regulate the leaf area in the first phase and photosynthetic activity in the second phase, in order to obtain high and stable yield.

Introduction

The poor response of indica rice varieties to nitrogen has been reported, long ago, to limit rice yield in the tropics (CHANDLER 1962, NAGAI 1958, GRIST 1959). The only way to overcome this problem is to introduce high nitrogen response varieties.

In order to obtain high, stable yield with these newly introduced varieties, knowledge about their growth habit under tropical conditions has a great importance.

The present paper deals with some preliminary observations on the dry matter accumulation pattern in relation to the rate of photosynthesis and leaf expansion of a high nitrogen response rice variety introduced in North Vietnam some years ago.

Material and Method

In all experiments, the rice variety Dwarf Chan chau was used, the vegetative period of which is about 120 days. Dwarf Chan chau rice has short straws and erect leaves. The rate of dry matter accumulation was followed by taking samples at 5 places from each field plot every 10 days. Dry weight was measured after drying the plants in an oven at 80 °C for 12 hours. Difference in dry weight per square meter between two consecutive sampling was expressed as dry matter accumulation rate ($W_2 - W_1$).

Leaf area index (LAI) was expressed as the total active leaf area per square meter. Leaf area was measured every 10 days, by weighing the photocopy of the leaves on photosensitive paper. From W and LAI the productivity of photosynthesis was calculated as follows:

$$P = \frac{W_2 - W_1}{\frac{LAI_1 + LAI_2}{2} \times 10}$$

This formula expresses the amount of dry matter accumulated per unit leaf area per day.

Chlorophyll content of leaves was determined spectrophotometrically and total nitrogen content by the Kjeldahl method.

Other field experiments were carried out in 40 m² plots in four-fold replication when final yield was determined.

Results

As shown in Fig. 1, the rate of LAI (△LAI) increases continuously after transplantation and reaches a maximum before the ear-initiation stage. At the same time we observed two maxima of P during the growth process (Fig. 2). The first peak of photosynthetic productivity appears at the stage of maximum tiller production, the second at the flowering stage. The same figure observed for the chlorophyll and nitrogen content of leaves indicated that P greatly depends on these factors.

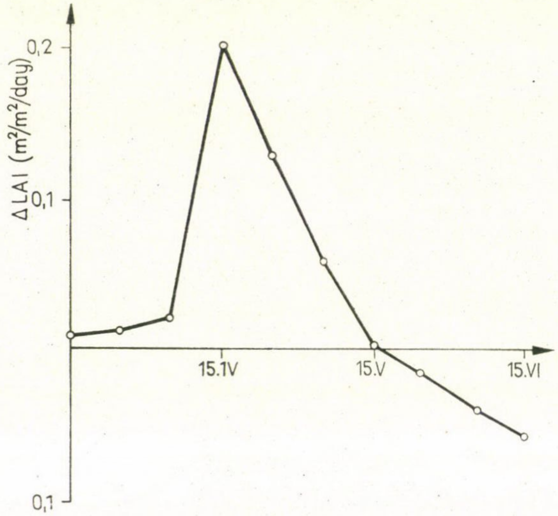

Fig. 1. Dynamics of leaf expansion rate (△LAI) during growth of the rice plant

Fig. 3 shows the dry matter accumulation pattern of Dwarf Chan chau rice during growth. △W is small at the tillering stage, but increases rapidly after flower differentiation and reaches a maximum at about heading time. The great value of △W at heading time cannot be explained simply by the increase of LAI, because LAI practically remains unchanged during this time. On the other hand, △W during heading time seems to be in close relation with the second peak of photosynthetic productivity.

The life of the rice plant has been described by several authors as a process consisting of several distinct phases (Grist 1959, Matsuo 1955, Togari—Matsuo 1962, Bui 1965, Ting 1963). As shown in Fig. 1, 2 and 3, from

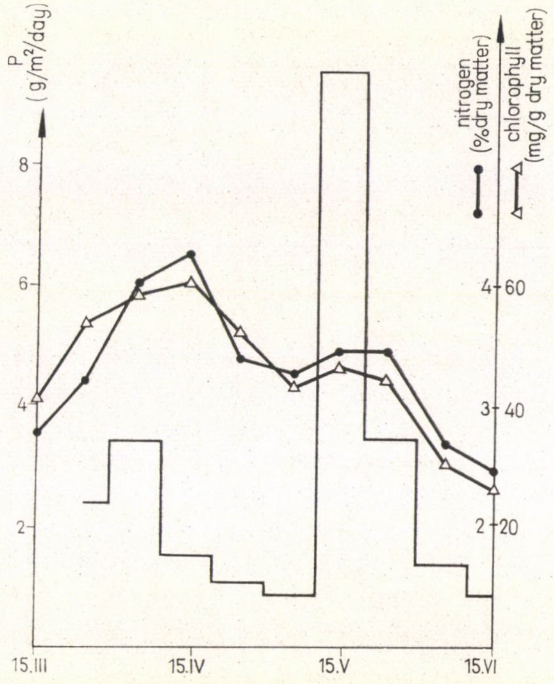

Fig. 2. Dynamics of changes in nitrogen, chlorophyll content and photosynthetic productivity (P) during growth of the rice plant

the point of view of dry matter production and photosynthesis, the life of the rice plant can be divided into two main phases, each having their own physiological characteristics. Under our experimental conditions the period of flower differentiation divides these two phases. In the first phase, dry matter accumulation is connected with rapid leaf expansion, as well as with high photosynthetic productivity. At the end of this phase, as LAI increases continuously, P decreases and reaches a minimum value at the flower differentiation period. Thus, leaf expansion plays a key role in dry matter accumulation during the first phase.

In the second phase, as LAI remains unchanged or even decreases in some cases, dry matter accumulation depends mainly on high photosynthetic productivity.

As has been discussed by several authors (MURATA—OSADA—IYAMA 1957, MURATA 1961, LINZAND—BROVTSINA 1964), photosynthetic activity of the rice plant depends on many factors, for instance, on the nitrogen content of the leaves (especially the flag leaves) on sun light intensity and duration, on the water supply etc. The dependence of LAI of the rice plant on the amount of nitrogen applied has also been reported (MURATA 1961, TANAKA—NAVA-

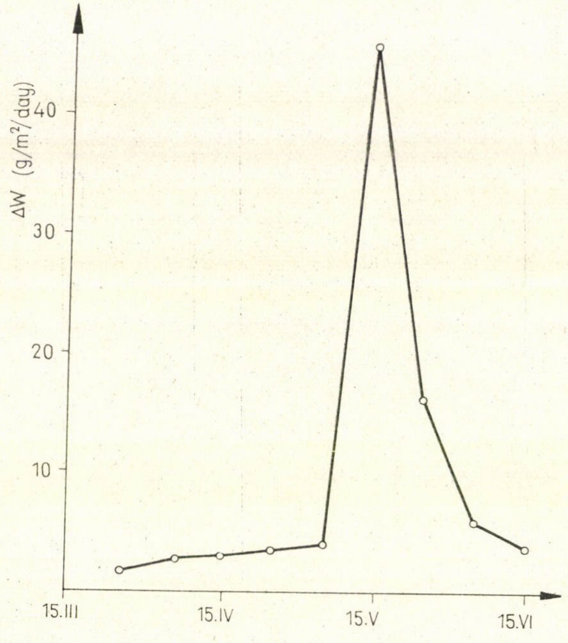

Fig. 3. Dynamics of dry matter accumulation rate (△W) during growth of the rice plant

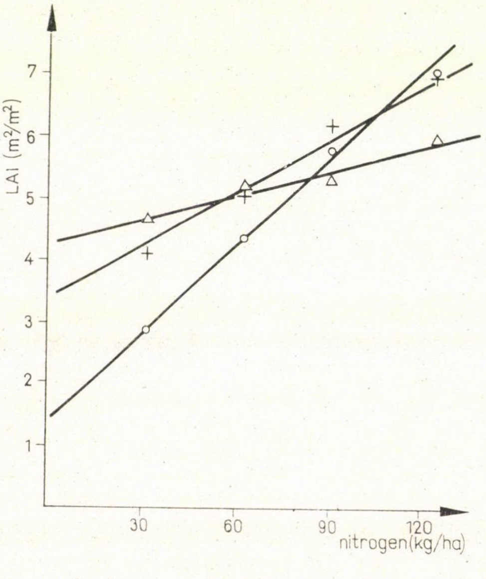

Fig. 4. Dependence between leaf area and amount of nitrogen applied at various growth phases. ○——○ tillering stage; +——+ 20 days before heading; △——△ 5 days after heading

SERO—GARCIA—PARAO—RAMINEZ 1964, SUDZUKI 1958). However, this dependence is not the same over the vegetative period of the rice plant. As shown in Fig. 4, in all growth stages a linear dependence between LAI and the amount of nitrogen applied is obtained. But as the rice plant grows, the dependence of LAI upon nitrogen supply becomes continuously weaker. As one can observe in rice growing practice, excess amount of nitrogen at the tillering period gives rise to a luxurious growth of leaves and leads to mutual shading of the plant and lodging. After the floral differentiation period the dependence of LAI upon nitrogen dressing is so weak that one can use high amount of nitrogen without the danger of lodging. Therefore, in the second phase, nitrogen can be safely used in order to increase the photosynthetic productivity of the rice plant.

As the root system of rice is often partly deteriorated after heading (TOGARI—MATSUO 1962, SUDZUKI 1958) foliar application of nitrogen at this phase has been proved to be very efficacious (NAGAI 1958, SUDZUKI 1958). This is in line with our field experiments as shown in Table 1.

Table 1

*Effect of foliar application of nitrogen after heading on rice yield**

Treatment	Yield kg/ha	1000 grain weight (g)
Control	3390	19.3
Ammonium sulfate 1%	3780	20.3
Urea+Potassium chloride 1%	3530	19.4

* Sprays of nutritional solutions were performed three times of 5-day intervals after complete heading at a rate of 600 l/ha.

That a great part of dry matter contributing to rice yield is due to photosynthesis after heading, has been reported by several authors (TING 1963, LINZAND—BROVTSINA 1964, ARAKI 1962). This is also shown by the data mentioned above, as the second phase is characterized by high photosynthetic activity and high rate of dry matter accumulation. In order to clarify the role of photosynthesis after heading in total dry matter accumulation, we carried out an experiment to investigate the contribution of the leaf system to the final grain yield during the time from heading to ripening. The results of this experiment are shown in Table 2 indicating the important role of the upper leaves, especially that of the flag leaves in dry matter accumulation.

In order to obtain high and stable yield with these new varieties, at the end of the first phase, the leaf area index must reach the maximum value

Table 2

*Effect of shading of the leaf system after heading on rice yield components**

Shaded leaves	Yield components**	
	Panicle weight (%)	1000 grain weight (%)
Control (without shading)	100	100
Flag leaf	74	81
Flag leaf +1st leaf	50	68
Flag leaf +1st leaf +2nd leaf	45	51

* Leaves were shaded by covering with thin layers of dark (inside) and white (outside) paper.

** Mean value of 100 plants.

without mutual shading (under our experimental conditions for Dwarf Chan chau rice this value is about 5—6). From the high response of leaf area to nitrogen application, the best way to regulate the leaf area in the first phase is nitrogen dressing. It is very important in the second phase to maintain the active leaf area and to increase the photosynthetic productivity of the leaf system. Two main factors are involved: nitrogen content of the leaves and light. By top dressing or by spraying nitrogen solution, the nitrogen content of leaves can be maintained at certain level. Unfortunately, in tropical regions the climate in April and early May (duration of the second phase) is generally characterized by a highly variable number of sunshine hour and the rice yield of the spring crop depends greatly on the climate conditions. However, by appropriate techniques, like early sowing and transplantation as well as nitrogen application, the climatic problems can be partly overcome.

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RELATIONSHIP BETWEEN THE EVAPOTRANSPIRATION OF RICE AND PAN EVAPORATION

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A two-year study of the relationship between evapotranspiration and pan evaporation — Class "A" pan and GGI 3000 pan — indicates that the ratio of ET/E is almost constant for the vegetative, reproductive and ripening stages of rice growth. A monthly and seasonal ratio of "1" is recommended for areas with conditions similar to those in the experiment. There was no significant difference between Class "A" pan and GGI 3000.

Introduction

The classical studies of Briggs and Shantz published in 1914 and 1917 (VIETS 1962), revealed a striking correlation between evapotranspiration (ET) and pan evaporation. Since then, many studies have been conducted on rice which included such comparisons. These studies indicated that the pan data could be used to estimate ET (THONGTAWEE 1965, PALYASOOT 1965, CHAUDHURY—PANDEY 1966, KATO *et al.* 1967, VAMADEVAN—DASTANE 1968, NAKAGAWA 1969). It appears that the use of evaporation pans as a practical tool for predicting ET in the rice field is promising, where reliable measurements have been made and pan environment has been fairly standardised throughout the growing season. At the same time, it may be mentioned that the coefficient derived for a specific region may not necessarily and automatically be applicable to other territories with completely different conditions of climate, soils and cultivation practices. An experiment was conducted to establish the relationship between the measured ET at two water depths and the evaporation from the Class "A" pan recommended by WMO as well as the GGI 3000 pan standardized in the USSR.

Material and Method

The study was conducted during 1968 and 1969 at the State Farm, Mezőtur — a typical rice growing area in the great Hungarian plain. The elevation is 83 m and it is situated 47 °C, 20.31 °E. The annual precipitation is 550 mm.

The ET was measured using galvanized iron tanks with 50×50 cm measurements and a depth of 80 cm, embedded in the centre of the rice field. Daily measurements of ET were made using the "Héni-Tóth" type gauge which had been used as a standard instrument for measuring ET in Hungary. 20 tanks each were embedded at water depths of 5 and 20 cm. Measurements of ET were made at 8 A.M together with a measurement of precipitation, if any, for convenience in the amendments of measured values.

A standard rain gauge and a thermohygrograph were installed at each water depth to measure rainfall, temperature and humidity. Gross solar radiation data were taken from the Meteorological Station at Szarvas, which is situated 6 km away from the experimental field. The two types of pan most widely used all over the world, namely the Class "A" pan and the GGI 3000, were also installed in the experimental field.

Fig. 1. A view of the tanks set in the rice field to measure evapotranspiration

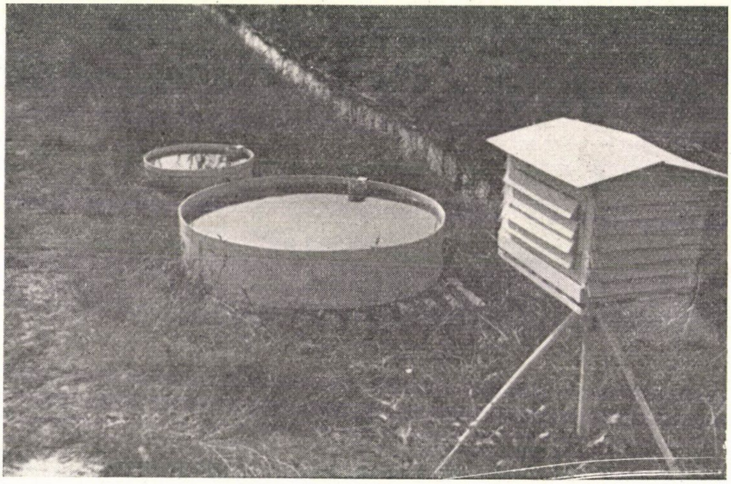

Fig. 2. A view of U.S.A. Standard "A" pan and GGI 3000 sunken pan installed in the rice field

Results

The variations of ET during the rice growing period can be estimated by obtaining the ratio between ET in the rice field and the pan evaporation, eliminating the influence of meteorological factors. The monthly ratios were investigated with evaporation from a Class "A" pan and a GGI 3000 and 2500 cm² tank embedded in the rice population.

Table 1 shows the monthly ET/E ratios. The following observations can be made from the above Table.

Table 1

Evaporation of rice with respect to pan evaporation

Year	Item	June		July		Aug.		Sept.		Total	
		5 cm	20 cm	5 cm	20 cm	5 cm	20 cm	5 cm	20 cm	5 cm	20 cm
1968	"A" pan	0.86	0.99	0.82	0.84	0.83	0.85	—	—	0.84	0.89
	GGI 3000	0.82	0.95	0.83	0.85	0.81	0.83	—	—	0.82	0.88
	2500 cm² tank	1.04	1.06	1.29	1.29	2.10	2.50	—	—	1.30	1.40
1969	"A" pan	0.85	0.96	0.94	0.99	1.12	1.20	1.31	1.30	1.05	1.11
	GGI 3000	0.91	1.02	1.06	1.13	1.12	1.18	1.34	1.33	1.10	1.16
	2500 cm² tank	1.00	1.00	1.15	1.13	1.67	1.69	1.75	1.69	1.38	1.38

1. In 1968 monthly ET/E ratios appear to remain within the range of 0.9 for "A" pan and GGI 3000, whereas in 1969 the ratio tends towards a higher value, that is 1.1. This may be due to the high midsummer adjective conditions which prevailed that year (VAMADEVAN 1970). The ET/E from the tank embedded in the rice field is initially low, but increases with the growing season. A maximum value was reached in August in both years. This tendency differs with the value of ET, itself.

2. In general, the ratio inclined to decrease during 1968, when there were more rainy days. The size of the ratio does not necessarily mean the degree of the ET.

3. The ratio is slightly higher at 20 cm water depth than at 5 cm in all the months.

4. A seasonal ratio of "1" may safely be adopted for areas with conditions similar to those in the experiment with the assurance that the error will not exceed 16%.

5. It is observed that there is no significant difference between the Class "A" pan and the GGI 3000.

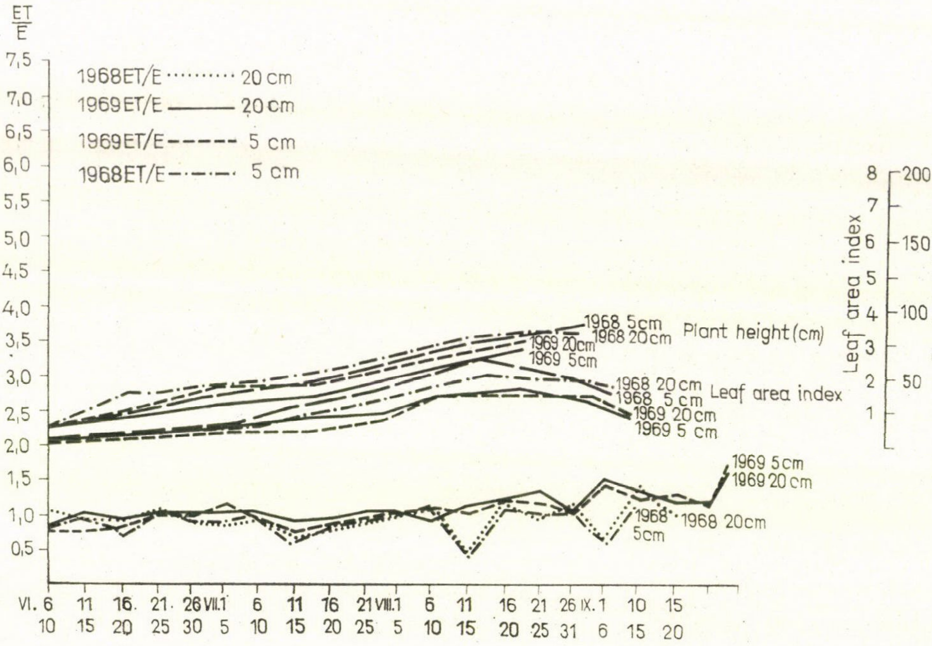

Fig. 3. The changes of ET/E (from class "A" pan) at 5 cm and 20 cm water depths with plant height and leaf area index

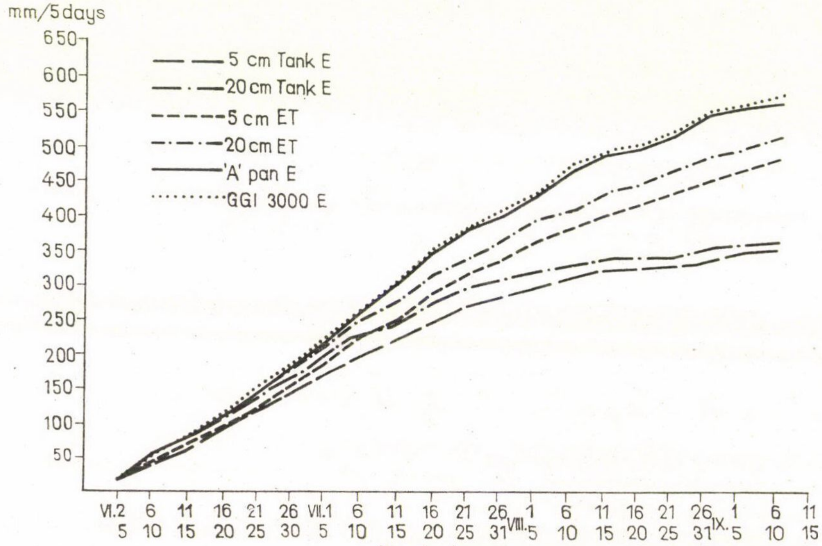

Fig. 4. Cumulative ET compared with cumulative E from U.S.A. Standard "A" pan, GGI 3000 and tank evaporation (1968)

6. The ratio of ET/E (Class "A" pan and GGI 3000) is almost constant for the vegetative, reproductive and ripening stages. The ratio does not change with the crop height and leaf area index either (Fig. 3).

Fig. 4 shows cumulative ET when compared to cumulative evaporation. The cumulative ET and E show the same slope. This indicates that in the rice field under flooded conditions, the relationship between cumulative ET and cumulative E from open water surface is linear throughout the season, and not as in other crops in arid climates, as reported by STANSHILL (1962). Thus, basically ET is more a function of the climate.

This shows that under flooded field conditions, there is a considerable relationship between pan evaporation and ET, when this relationship is determined for mean monthly values.

Thus a seasonal ratio of "1" may safely be adopted for the rice growing areas of Mezőtúr, with the assurance that the error will not exceed 16%. Assuming that it is true that this average value immediately shows the mistake, we cannot forget that ET is more a statistical value and thus its precision for all practical purposes should not go beyond oscillations characteristic of determinative factors, such as climatic and plant factors. The above consideration is supported — at least in preliminary and practical appraisal — when the given ratios are compared with ET values themselves. In other words, within the scope of technical operations of irrigation projects, the error in the suggested ratio for the evaluation of ET is perfectly admissible — both because of the statistical nature of the data and its magnitude, when compared with the conveyance losses, percolation and over-irrigations in the rice field.

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EFFECT OF GAMMA IRRADIATION ON QUANTITATIVE CHANGES IN THE CARBOHYDRATE CONTENT OF GERMINATING PEAS

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Authors examined the effect of radiation on the ratio of starch to sugar-like carbohydrate in pea cotyledons in connection with the starting of germination. They found that on the first day following the irradiation the total carbohydrate content of the seed increased, while the quantity of soluble sugars decreased by 25%. This decrease was then followed by an immediate 10—20% increase, then on the 9th day the soluble carbohydrate fraction of plants approached and attained respectively in all radiation treatments the sugar level of untreated plants. At the critical point of germination, on the fifth or sixth day after water uptake the amylase-complex reacted to the radiation treatments with an increased hydrolizing activity, as a result of which the dry matter related sugar content of treated seedlings exceeded by 2—8% that of the control. On the 9th day, on the other hand, carbohydrate percentage of treated seedlings was higher than that of the control only in the case of stimulating doses.

Introduction

Pea is a plant in which the whole amount of reserve starch is stored in the cotyledon. In the course of germination, as a result of a hydrolytic—enzymatic decomposition of the starch, the carbohydrates are mobilized; this transformation is visibly indicated by the gradually increasing corrosion of starch grains.

On the fifth day of germination **Young—Varner** (1959) observed a remarkable increase in the α-amylase activity which they considered to be the result of an intensive enzyme synthesis demonstrable in the tissues. Apart from investigations into the amylase-complex it is very important to know the fat—carbohydrate transformation (**Stumpf—Barber** 1956, **Beevers** 1961) and the intensity of respiration (**Spragg—Yemm** 1959), since it is only through a knowledge of these regulating mechanisms that a complete picture of the beginning of metabolic reactions can be obtained. The whole of these biochemical changes is well known, the effect of radiation on the mobilization of nutrients has not been, however, clarified.

When studying the carbohydrate metabolism **Wassjuk** (1958) and **Breslavec—Beresina** (1956) after having soaked sugar-beet seeds in radioactive solution. and irradiated the plant during the whole vegetative period respectively, (0.02 r/day), found a 0.5—2.1% absolute increase in the sugar content.

Although it is necessary to refer to results obtained by RUBIN *et al.* (1959) with potato, nevertheless it would be a mistake from many aspects to draw a parallel between the storage mechanism of potato and that in pea. It should be mentioned among others that the starch—sugar transformation in the tuber is resulted by the activity of the starch phosphorylating system rather than by that of the amylases, or that above authors examined the changes of carbohydrate metabolism exclusively in relation with the germination inhibition of potato. On the other hand, their discovery of irradiation being followed by a sugar accumulation increasing for 60 days is very interesting. HOLSTEN (1965) has a similar opinion: namely, that sugar is produced in the developing cells as an indirect effect of radiation.

Literature gives, thus, little information on the radiobiological effect of radiation on the process of germination. For the very reason it is necessary to examine the correlations between radiation and the dynamics of carbohydrate metabolism, for a knowledge of the possible changes may provide valuable data on the nature of enzymatic reactions taking place in the course of germination.

Material and Method

The pea variety IP_1 was used as experimental material. 50 seeds per treatment, preswollen at room temperature were irradiated by means of a CO^{60} gamma radiation apparatus on the day following the water uptake (doses: 0.5; 5.0; 10.0; 20.0 Kr). The duration of a treatment was 1 hour. Observations concerning the quantities of total and sugar-like carbohydrates were carried on until the 9th day after water uptake. The carbohydrate content was determined on the basis of a phenol: sulphuric acid colour reaction with the "Spektromon 360" photometer after Balázs (SZALAI—FRENYÓ 1962). Dispersion of the carbohydrate content of pea seeds as related to the dry matter content was $\pm 1.5\%$. The experimental data are mean values of our three replication experiment expressed in relative and absolute percentage, respectively.

Results

The outset of germination is in connection with the water uptake by the protoplasma and the increased intensity of metabolic processes (respiration and other metabolic transformations) too. The insoluble polysaccharides, fats and protein grains contained in the cotyledon of the seed can be transported only in a soluble form to the tissues of the embryo where cell division and elongation take place. According to the authors' experiments radiation can considerably modify these enzymatic transformation processes (Table 1) probably by altering the enzyme synthesis and the intensity of respiration. On the day following irradiation the total carbohydrate content of seeds seemingly increases parallelly with the increased radiation doses, in contrast with the soluble sugars the amount of which decreases by about 25%. A day later, on the other hand, the inhibition stops, and under the influence of

Table 1

Effect of radiation on the enzyme decomposition of carbohydrates in pea cotyledons

Treatment	Germination (day)										
	3		4			6			9		
	Embryo + cotyledon		Cotyledon			Cotyledon			Cotyledon		
			total carbohydr.			total carbohydr.			total carbohydr.		
	sugar cont. relative %	total carbohydrate cont. as % of dry matter	sugar relative %	as % of dry m.	mg	sugar relative %	as % of dry mat	mg	sugar relative %	as % of dry matter	mg
Control	100.0	56.4	100.0	52.8	1058.0	100.0	59.2	990.0	100.0	54.4	872.6
0.5 Kr	72.1	59.2	117.2	63.0	1237.0	104.5	50.8	1007.4	106.0	56.4	791.2
5.0 Kr	75.4	62.0	120.7	57.6	1078.8	97.7	46.4	812.9	93.9	44.0	622.2
10.0 Kr	70.9	62.8	117.6	50.0	929.0	81.8	46.4	861,6	100.0	31.0	499.7
20.0 Kr	70.9	63.0	110.3	58.0	1108.4	104.5	54.0	967.7	105.5	48.0	736.3

Note: values expressed in mg related to 10 seeds

Table 2

Changes in the total carbohydrate content of the seedling following the irradiation of the seed

Treatment	4th day		6th day		9th day	
	Total carbohydrate content					
	in dry matter percentage	mg (10 seeds)	in dry matter percentage	mg (10 seeds)	in dry matter percentage	mg (10 seeds)
Cotrol	14.0	8.54	20.0	29.40	16.8	46.70
0.5 Kr	17.2	11.18	24.8	35.46	20.0	59.60
5.0 Kr	17.1	9.74	28.4	32.92	16.0	37.76
10.0 Kr	16.0	9.92	22.4	36.73	16.8	48.38
20.0 Kr	16.0	10.88	25.2	30.99	18.4	46.36

radiation treatments the soluble sugar percentage of cotyledons exceeds that of the control. In the subsequent course of germination no sugar accumulation could be observed. Comparison between the data of Table 1 and 2 shows that the most crucial point of germination is on the fifth or sixth day after water uptake (Table 2). In this period the total carbohydrate content suddenly increases in the control, but as a result of irradiation, this phenomenon is even more expressed in the treated plants. In this respect, on the 9th day of germination only the 0.5 Kr treatment shows a significant difference as compared to the untreated plants.

Conclusions

As it is shown by the data published, radiation induces changes in the metabolism of the cell, since it results in an apparent increase in the total carbohydrate content and a quantitative decrease in the sugar-like carbohydrates, respectively. The differences can probably be explained by an inhibition caused by radiation in the decomposing activity of amylases, further, by sugar being produced in the cells as the end-product of other metabolic processes. This theory is confirmed also by previous observations, namely, that following the irradiation, simultaneously with a 3–10% increase in the carbohydrate content the amount of fats decreases as compared to the control (depending on the dosis).

The different biological effects of the individual radiation doses are realized in the alteration of the speed of reaction. Differences are probably connected with respiration. In conformity with the literature, on the fifth or sixth day of germination the carbohydrate content of seedlings suddenly increases, especially in the irradiated plants. If this change is attributed to a further enzyme synthesis, which on the basis of the ratio between starch and soluble carbohydrate in the leaves seems to be justified, so radiation induces soluble sugar formation by increasing the biosynthesis of amylases.

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EFFECT OF FEEDING OF DIFFERENT INTENSITY ON GROWTH AND SEXUAL ABILITY OF YOUNG REPLACER BULLS

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One of the two groups was fed on the level of nutrition prescribed by the valid standard (100%), the other was given 30% less amount of nutrients.

Relying upon the results it can be stated that 30 per cent reduction in the level of feeding between 6 and 18 months of age resulted in 10 per cent difference in body weight. Owing to the poorer nutrient supply the wider height decreased significantly, but, the relative body measurements proved to be more favourable in the experimental group. The reduction in the level of feeding had not effect on the rate and rhythm of growth, quality and quantity of semen and ejaculating ability. Food conversion was better in the 70 per cent group, the differences were 20 and 25 per cent regarding digestible protein and starch equivalent, respectively.

Introduction

The influence of nutrition of different intensity on the organism of young bulls got into the centre of interest in connection with the aim of longevity. The useful time of a breeding sire is relatively short, the extension of which — especially since breeding selection on basis of progeny testing becomes general in countries having high level animal husbandry — is then an important task. Ever since Hansson's experiments (1954) drew the attention to the fact that the feeding of different intensity had a beneficial effect on longevity and milk yield, while the sexual functions of animals fed in such a manner were also normal in every respect, the feeding of replacement bulls in rearing period has been investigated for the sake of lengthening of the useful time.

In Hungary, the feeding of young bulls in bull rearing state farms is predominantly aboundant. This plentiful feeding is supported also by the new standards being in force.

The mean age of bulls at the artificial inseminating stations is about 6 years. There is no doubt that feeding technique plays — during the rearing period — an important role in this short longevity of sires. Consequently, the reasonable nutrition of young replacement bulls is an essential problem in cattle breeding, especially now when the determination of the breeding value of a bull by performance test takes relatively long time.

The problem is common hence the reasonable feeding of young bulls is virtually investigated all over the world. First of all it is the effect of feeding with different intensity that comes into prominence (Bane 1954, Flipse—Almquist 1961, Smerha—Zeisberger 1962).

As far as sexual function is concerned, moderate feeding has no influence in general on the quality and quantity of the semen. Bonnier—Hansson—Skjervold (1948), Fulka—Pavlok (1962), Denmark—Manger (1964). Kords—Hildebrandt (1958) reported that moderate feeding did not affect conception.

The effect of moderate feeding of young bulls intended for breeding purposes — the beneficial effect of which on longevity is well known from literature or rather on the basis of foreign investigations — has been investigated not for the sake of feed saving.

We aimed at making clear that how Hungarian Red and White male replacement calves originating from bull-rearing (peak) cows react to less than usual feeding or rather, how physiologically more reasonable, moderate feeding could be practized under Hungarian conditions. We did so because the establishments on the intensity of nutrition obtained with other breeds, feeds, under unlike environmental conditions cannot be adopted without any alteration.

Table 1

Actual feed and nutrient intake of breeding bulls fed on different level

Period	Groups	Concentrates	Hay	Dry slices of turnips	Wet slices of turnips	Green fodder	Silage
From 7 to 12 months	A	452.15	379.49	111.18	33.71	161.47	1414.51
	B	269.15	265.58	43.54	38.25	137.38	1124.57
From 13 to 18 months	A	541.62	320.74	59.37	146.63	2533.07	917.32
	B	376.59	237.62	31.81	53.30	1595.00	953.86
From 7 to 18 months	A	993.77	700.23	170.55	180.34	2694.54	2331.83
	B	645.74	503.20	75.34	91.55	1832.38	2078.43

Group	Starch equivalent consumption		
	difference kg	t	P %
A—B from beginning to 18 months' age	448.31	9.91	⩽0.1

Material and Method

In 1962—1965 experiments were conducted at Nyékládháza bull rearing farm belonging to the Board of Borsod-county State Farms in order to verify, how 30 per cent reduction of the nutrient standard commonly used at bull rearing farms affected the growth of replacement young bulls.

The 4—5 months old male calves originating from bull-rearing (peak) cows had randomly been allotted into two groups. These two groups were fed on the same level of nutrition till 6 months of age (so-called fore-experiment). From 6 months of age onwards the group A was given the nutrient supply prescribed by the standard recommended for bull rearing (100 per cent group). To cover this demand the feeding technique of Bábolna State Farm (one of bull-rearing farms) was adopted. The group B got only 70 per cent of nutrients offered to group A, thus it received a moderate nutrient supply. The trial was conducted to 18 months' age. The group A consisted of 23, while group B included 24 young bulls. On account of TBC infection, actinomycosis and fracture of leg, 10 young bulls had to be excluded from the experimental groups. Breeding selection had not been made. The experimental data collected refer to 19 young bulls of group A and 18 of group B.

Feed intake and feed conversion. Feed and nutrient intake as well as starch equivalent and digestible protein use up per 1 kg gain of weight of the groups reared on various nutrient level are summarized in Table 1 from 7 to 12 and from 13 to 18 months of age as well as summed up referring to the whole of the experiment (from 7 to 18 months of age).

In comparison to group A the feed conversion rates of group B were 21.9 per cent and 24.7 per cent more advantageous referring to starch equivalent and digestible protein, respectively. This difference was highly significant at a level of probability of 0.001. There has been a distinct correlation between starch equivalent intake and total gain as well as starch equivalent using up per 1 kg gain of weight and average daily gain. The correlation is closer in group B than in group A, which also verifies the better feed conversion of group B (Table 2).

Feed utilization. Utilization values calculated from the composition data of various feed intakes and faeces excretions are summed up in Table 3. The differences in coefficients of

of nutrition in kg, and group B expressed in per cent of group A

Intake per bull				Use up per 1 kg gain			
starch equivalent		digestible protein		starch equivalent		digestible protein	
kg	%	kg	%	kg	%	kg	%
668.63	100.0	107.62	100.0	3.08	100.0	0.50	100.0
446.40	66.8	70.32	65.3	2.45	79.8	0.39	78.0
848.55	100.0	131.39	100.0	4.67	100.0	0.72	100.0
622.47	73.3	91.98	70.0	3.50	75.0	0.52	71.5
1517.18	100.0	239.11	100.0	3.80	100.0	0.60	100.0
1068.87	70.4	162.30	67.9	2.97	78.1	0.51	75.3

Starch equivalent using up per 1 kg gain		
difference kg	t	P %
0.832	7.02	$\ll 0.1$

Table 2

Relationships of nutrient efficiency

Relationship	Group A			Group B		
	r	t	P%	r	t	P%
Total starch equivalent using up total gain	0.63	3.29	<1	0.77	4.77	<0.1
Starch equivalent per 1 kg gain, average daily gain	−0.79	5.33	<0.1	−0.95	12.26	<0.1

Table 3

Feed efficiency calculated on basis of composition of feed stuff and faeces of groups fed on various level of nutrition

Age, month	Group	Number	Dry Matter	Organic matter	Crude protein	Crude fat	Crude fibre	Nitrogen free extracts	Ash
18 months	A (100%)	4	70.73	73.47	64.82	81.26	68.55	76.19	36.22
18 ”	B (70%)	5	68.66	71.13	65.63	80.21	61.94	75.17	34.43
15 ”	A (100%)	3	71.65	75.06	65.83	74.36	67.69	79.16	30.73
15 ”	B (70%)	3	65.59	68.62	60.55	69.19	58.75	74.05	20.05
12 ”	A (100%)	4	72.15	74.32	67.98	84.00	68.61	76.79	47.75
12 ”	B (70%)	4	66.79	69.35	62.57	81.09	62.29	72.56	35.60
9 ”	A (100%)	5	73.06	75.74	68.31	76.76	68.06	79.06	36.37
9 ”	B (70%)	5	66.07	69.37	61.37	71.07	59.48	73.78	19.73

utilization of dry matter, crude protein and crude fibre are significant between 9 and 12 months' measures. The 15 and 18 months' data referring to the same animals do not show statistically significant differences.

Body weight and gain of weight. There was only about 10 per cent difference in average body weight of young bulls fed on various levels of nutrition (Table 4). The group B (70 per cent group) was backward in body weight with round 10 per cent at ages of 9 and 18 months, in comparison to group A. Though the initial weights of groups were not the same at the beginning of experiment, they did not show significant difference. At 9 months of age the difference is still significant for the good of group A. The average daily gain of group A showed a decreasing tendency. The relative growth in body weight was practically the same in each group, since group A reached 159.9 per cent and group B 163.9 per cent relative growth. There were no essential differences in any of the individual periods, as relative growth of group A was 22.8 per cent and that of group B 22.3 per cent between 9 and 12 months of age. These values between 15 and 18 months of age were 14.4 and 15.6 per cent, respectively, in groups A and B.

The situation is altered if the so-called performance-coefficient referring to body weight and starch equivalent use up was calculated by Brody's modified formula. According to data of Table 5 the performance-coefficient based upon body weight and starch equivalent intake of young bulls of group B fed on reduced level of nutrition were 16—33 per cent better than that of young bulls of group A.

Considering that the experiment was conducted throughout several years and that young bulls had not been drawn into experiment at the same time, investigations were con-

Table 4

Body weight and gain of weight of bull groups fed on various level of nutrition

	Body weight, kg			Average daily gain, g		
	A	B	group B in per cent of group A	A	B	group B in per cent of group A
	group			group		
Initial	268.2	243.8	—	—	—	—
At 9 months of age	301.1	268.7	89.2	1336	889	66.5
At 12 months of age	408.9	362.1	88.6	1228	926	81.3
At 15 months of age	509.5	452.1	88.7	1069	1016	95.5
At 18 months of age	590.7	539.9	91.4	928	975	96.5
From the beginning to 12 months of age	—	—	—	1248	926	81.3
From 12 to 18 months of age	—	—	—	999	964	96.5
From the beginning to 18 months of age	—	—	—	1088	981	90.2

ducted to make clear if years and seasons essentially affected gain of weight of young bulls kept on various levels of nutrition.

By three terms analysis of variance it was established that years and seasons were not essential sources of variance of the average daily gain but between groups, variation in gain of weight was significant on level of probability of 0.05.

Body measurements. In the course of processing the experimental data it was investigated whether the feeding of different intensity of the sires had greater influence on the main body measurements. Taking half-sib groups for basis of investigations we found (Table 6) that the feeding of different intensity was more influential (not significantly) on height of withers than the sires. On the contrary, on heart girth and trunk length it was the type of sires that had greater effect than the feeding of different intensity. The inter group variations were significant on level of probability of 0.01.

Table 5

Performance coefficient
(group B in per cent of group A)

Period	Group A		Group B	
	performance coefficient	%	performance coefficient	%
From the beginning to 12 months	17.4	100	20.2	116.09
From 12 to 18 months	11.4	100	15.2	133.33
From the beginning to 18 months	13.4	100	16.9	126.12

Brody's modified formula for the calculation of performance =

$$= \frac{\text{gain of weight, kg} \cdot 2000 \text{ cal}}{\text{starch equivalent intake, kg} \cdot 3760 \text{ cal}}$$

Semen quantity and quality. In studying the effects of feeding of different intensity the most decisive aspect is to know how bulls are willing to ejaculate and what is the quality and quantity of the first ejaculate.

Table 6

Estimation of the effect of feeding of different intensity and the effect of sires on height of withers, trunk length and heart girth by analysis of variance

Variance	FG	SQ	MQ	F
Height of withers between group A and B	1	36.03	36.03	2.11
within sires	4	68.33	17.08	1.52
rest	11	123.17	11.20	
Total	16	227.53		
Trunk length between group A and B	1	91.68	91.68	0.14
within sires	4	2138 44	634.61	11.11
rest	11	628.00	57.10	
Total	16	2858.12		
Heart girth between group A and B	1	138.01	138.01	0.70
within sires	4	789.38	197.34	8.21
rest	11	264.50	24.04	
Total	16	1191.89		

The ejaculating ability was practically the same in both of the groups. Although we endeavoured to get semen from the bulls at 11 months of age, the first ejaculation succeeded only at 13 months of age in each group. In Table 7 the data of semen classification are summarized. According to the values introduced the average quantity of semen produced was 3.34 cm^3 in group B (70 per cent group) and 2.48 cm^3 in group A (100 per cent group). Although the bulls fed on reduced level of nutrition produced larger quantity of semen this difference was not significant. It appears from Table 7 that the qualification of the semen collected from bulls of group B is generally better (mass motion, density, dilution rate), but these differences were not significant in any case.

Table 7

Judgement of semen at the ages of 13—14, 15—16 and 17—18 months

Age	Group A				Group B			
	quantity of semen	microscopical		percental scoring after dilution	quantity of semen	microscopial		percental scoring after dilution
		mass movement	density			mass move-ment	density	
13—14 months	2.48	3.19	3.00	48.1	3.34	3.72	3.16	52.0
15—16 months	3.77	3.44	3.36	50.8	3.83	3.05	3.28	40.4
17—18 months	4.25	3.44	3.19	53.6	3.86	3.43	4.00	57.1

Results

Feed conversion rate in the group fed on 30 per cent reduced level of nutrition — in full agreement with expectations — was more advantageous. The difference in digestible protein was 20 per cent and in starch equivalent 25 per cent. Relying upon informatory data of feed efficiency trials it appears that the utilization of the nutrients offered to young animals is relatively worse. Presumably this can be attributed to the fact that the amount of feeds rich in crude fibre per unit of live weight is relatively larger. At an age of 15—18 months such differences do not exist any more. Although the utilization of nutrients is slightly diminished in the 70 per cent group but simultaneously their resorption and infiltration into the organism are more favourable in comparison to the 100 per cent group.

The reasonable explanation of better feed conversion may be that the composition of body tissues of young bulls fed on various levels of nutrition are disparate. This is supported by an earlier paper of Czakó—Nagy—Guba (1962), who reported that with reduction in amount of nutrient offered the proportion of fallow decreased with 17 per cent, too, as compared to the control ones.

Moderate feeding — according to expectations — decreased the gain of weight. The difference in body weights of the two groups was about 10 per cent. Although this difference was statistically significant, this backward in body weight could not be harmful from biological point of view, especially if this was related to body measurements.

We found that the feeding with lower intensity applied in our experiment had influence only on height of the withers. The development of any other main body measurements (trunk lenght, heart girth) up to 18 months of age primarily depends on genotypic aptitudes and is less influenced by feeding. From these findings the conclusion can be drawn that a 30 per cent reduction of the presently applied feeding standards is beneficial to the formation of a desirable type of cattle, since the height of withers can thus be lowered without any decrease in trunk lenght and heart girth.

The rate of body development was not affected either in this experiment by feeding of different intensity. Also this finding is in good agreement with the results of the earlier report of Czakó—Nagy—Guba (1962), according to which there have been no significant differences in coefficients of growth of groups on various levels of nutrition.

There have been no significant differences either in the ejaculating ability, quantity and quality of the semen between the two groups. This distinctly referred to the fact that the function of adventitious gonads was not diminished which can exclude the hypothesis (Mann—Walton 1953) according to which in maintaining the spermatozoa concentration of the semen, the animals decompose the matters that contain protein of their organism.

The reduced level of nutrition was not influential on the quality of semen. Semen production and spermatozoa concentration were independent of feeding which reveals that here inherited factors were prevailing.

Conclusions

Summing up our results it can be stated that a 30 per cent reduction in nutrient standards prescribed for bull rearing farms is beneficial from 6 to 18 months of age. On this moderate level of nutrition the weight of young bulls is about 50—60 kg less at 18 months of age, still reaching the desired development, body conformation and muscularity as compared to the standards of the breed. Semen production and ejaculating aptitude have not been affected by the reduced level of nutrition. Relying upon literary reports the useful time of sires fed this way is presumably prolonged which is desired especially in consideration of progeny testing.

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ONTOGENETICAL STUDIES ON THE GROWTH OF SOME RYEGRASS VARIETIES IN COMPARISON WITH BARLEY

By

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The barley plant recorded its maximum height 101 days after sowing where ryegrasses were only at about 1/3—1/2 of their full height. Barley exceeded greatly ryegrasses in the leaf area up to 101 days after sowing. Maximum number of leaves, tillers and leaf area were recorded on barley earlier than on ryegrasses, while the maximum number of tillers on ryegrasses was higher than that of barley. Barley flowers 8—10 weeks earlier than the ryegrass varieties. The dry weight of the barley plant as well as its comparent parts exceeded greatly the ryegrasses up to 101—111 days, while ryegrass varieties showed their maximum values later in the season, when Westerwolds and Tetrone varieties exceeded the Normal variety. The maximum dry weight of ryegrass plants was obtained at the same date of maximum tillering with the exception of the Westerwolds variety.

Introduction

Ryegrass is one of the most important forage crops known abroad and has recently been introduced to U.A.R. On the other hand, barley is usually cultivated in U.A.R. for grain production and is grown by some farmers in association with berseem to prevent or minimize the danger of bloat. These two kinds of grasses are used as forage crops either alone or mixed with legumes.

Norman (1933) found that the average height of, barley plant increased continuously to reach a maximum 91 days after sowing. The number of tillers increased to reach a maximum 10 weeks after sowing, then tended to decrease. He added that the dry weight gave a sygmoid curve with a point of inflection between 91 and 98 days after sowing coinciding with the period of the greatest increase.

Sotola (1937) reported that the height of Hasford barley continued to increase until it reached a maximum 76 days after sowing. Kamel (1959) found that the Heine 4804 barley variety was increased rapidly in length in the early stages of development, then less rapidly until it came to a standstill. He noted that the internodes increased progressively in length and in number as the plants advanced in age. The shoot and green leaf number increased with age till a maximum, then decreased. The dry weight of roots, stems and leaves increased with age reaching a maximum, then decreased. On the other hand, the dry weight of spikes continued to increase till the end of the season.

El-Moursi *et al.* (1963) concluded that the height of Westerwolds ryegrass plant increased steadily till 128 days after sowing, thereafter no considerable changes were recorded till the end of the experiment. The tiller and leaf number as well as the leaf area recorded two peaks 100—107 and 135—142 days after sowing. Raafat *et al.* (1963) found that the dry weight of the stems and leaves of the same variety increased slowly in the establishment period up to 79 days after sowing, then recorded two peaks 107 and 142 days after sowing followed by a decline till the end of the season.

The aim of the present work is to study the seasonal changes in growth of some ryegrass varieties in comparison with barley.

Material and Method

The present work has been carried out in the Faculty of Agriculture, Ain Shams University, U.A.R. and includes the study of three ryegrass varieties namely: *Lolium multiflorum* Lam. var. normal, Tetrone and Westerwoldicum. The seeds of the first two varieties (Italian ryegrasses) were obtained from the General Egyptian Organization for Land Settlement, while seeds of the latter were obtained by Goldsmith Bros. Ltd. Suffolk, England. The barley variety used was *Hordeum vulgare* L., variety Baladi 16 and its seeds were obtained from the Ministry of Agriculture, Egypt.

The experiment consisted of 120 pots each containing 5 kg clay loamy soil. Seeds of each variety were sown on December 5, 1963 in thirty pots using the normal rate of sowing (12 kg/feddan for ryegrasses and 60 kg/feddan for barley). Fertilization was made for all pots on Dec. 30th at the normal rate (150 kg/feddan for each of calcium nitrate 15.5% N and calcium superphosphate 16% P_2O_5) and plants were irrigated whenever needed.

Samples were taken periodically every 15 days beginning on Jan. 30, 1964. For each sample, two pots were taken at random from each group and data of plant height, number of tillers, leaves and spikes as well as leaf area were determined. Moreover, plants of each sample were separated into roots, stems (stems + sheats), leaves (blades) and spikes when they were available. After fresh weight determination, plant parts were dried at 70 °C for 48 hours to obtain the crude dry weight.

Results

Data concerning the seasonal changes in plant height, number of tillers, spikes and leaves as well as leaf area of barley and ryegrass varieties are presented in Table 1.

a) *Plant height.* It is clear from the data that barley plants continued to increase in height to reach a maximum 101 days after sowing, then tended to be stable till the end of the experiment. The ryegrass varieties generally showed a continuous increase towards the end of the experiment. Results of like characters were obtained by Kamal (1959) with barley and El-Moursi *et al.* (1963) with Westerwolds ryegrass.

The barley plant recorded its maximum height 101 days after sowing where ryegrass varieties were still only at about $^1/_3$—$^1/_2$ of their full height. At this stage, the barley plant recorded 71.2 cm against 18.6, 23.3 and 32.4 cm for Normal, Westerwolds and Tetrone varieties respectively. It could be noticed that the variety Normal showed the lowest values of plant height throughout the whole season and the barley plant ended its life two months prior to the ryegrass plants.

Table 1

Seasonal changes in plant height (cm), number of tillers, spikes and leaves and leaf area (cm^2) of barley and ryegrass varieties

	Sample		2	3	4	5
Barley	Plant height	34.8	51.0	69.4	71.2	65.6
	No. of tillers	3.7	5.2	5.1	8.2	5.4
	No. of spikes	—	—	2.7	3.8	5.4
	No. of leaves	10.1	19.4	22.8	31.8	19.7
	Leaf area	93.2	240.7	227.8	313.4	133.1
Tetrone	Plant height	16.2	14.4	25.6	32.4	32.9
	No. of tillers	3.5	3.7	7.4	6.1	5.8
	No. of spikes	—	—	—	—	—
	No. of leaves	6.6	5.2	15.3	14.3	12.6
	Leaf area	14.4	12.0	72.5	74.4	46.9
Westerwolds	Plant height	15.3	16.7	25.9	23.3	30.6
	No. of tillers	5.4	4.0	7.1	5.7	8.5
	No. of spikes	—	—	—	—	—
	No. of leaves	9.7	7.4	15.3	13.7	18.2
	Leaf area	14.3	15.8	76.7	51.7	91.9
Normal	Plant height	14.1	12.0	13.2	18.6	19.4
	No. of tillers	6.7	3.6	5.7	6.7	6.6
	No. of spikes	—	—	—	—	—
	No. of leaves	13.4	7.3	12.9	14.1	13.9
	Leaf area	22.7	10.2	26.1	48.7	40.8

	Sample	6	7	8	9	10
Barley	Plant height	67.9	—	—	—	—
	No. of tillers	4.8	—	—	—	—
	No. of spikes	5.4	—	—	—	—
	No. of leaves	8.5	—	—	—	—
	Leaf area	55.5	—	—	—	—
Tetrone	Plant height	34.4	38.3	58.7	69.4	74.0
	No. of tillers	6.5	6.9	13.2	5.9	4.8
	No. of spikes	—	—	3.1	1.6	1.5
	No. of leaves	14.5	15.4	27.6	11.9	5.5
	Leaf area	99.7	158.2	223.2	107.5	25.2
Westerwolds	Plant height	39.8	54.7	82.9	84.0	86.9
	No. of tillers	9.5	8.0	8.7	5.6	4.3
	No. of spikes	—	2.3	4.9	2.6	2.6
	No. of leaves	22.8	21.6	19.3	12.1	—
	Leaf area	161.4	160.8	129.2	57.2	—
Normal	Plant height	19.7	23.1	39.6	42.8	57.7
	No. of tillers	5.0	5.3	9.8	6.1	5.8
	No. of spikes	—	—	0.6	1.0	1.6
	No. of leaves	10.9	11.0	20.9	12.0	7.7
	Leaf area	30.1	38.8	115.9	54.4	23.1

b) *Number of tillers.* The data show that the number of tillers in all varieties studied continued to increase to reach a maximum, then decreased till the end of the season. This decrease could be mainly due to the increase in the rate of tiller death as the plants reached maturity. A similar trend was obtained by KAMEL (1959) with barley and EL-MOURSI *et al.* (1963) with Westerwolds ryegrass. The data showed that the barley plant recorded its maximum number of tillers earlier than the ryegrass varieties, although the latters exceeded the formers in this number. Maximum numbers obtained were 8.2, 13.2, 9.8 and 9.5 tillers per plant for barley, Tetrone, Normal and Westerwolds varieties respectively. It could be seen also that Westerwolds variety gave its maximum tiller number about one month earlier than the other two varieties. These results might bear some economical importance in using these varieties as green forage crops.

c) *Number of spikes.* It is clear from the data that the barley plant started flowering nearly 8 weeks earlier than Westerwolds ryegrass variety and 10 weeks earlier than the other two ryegrass varieties. The highest number of spikes was recorded on barley as the maximum values obtained were 5.4, 4.9, 3.1 and 1.6 spikes per plant for barley, Westerwolds, Tetrone and Normal varieties respectively. It is also clear that these maximum numbers were reached at the same date of that of maximum tiller production in Tetrone, while it was 15 days later in barley and 30 days later for Westerwolds and Normal ryegrass varieties.

The drop noticed in the number of spikes of the Westerwolds and Tetrone varieties of later stages of growth might be due to the breaking off and loss of some spikes as the plants approached the end of their life cycle. This might be due to the increase in plant height noticed in these two varieties in comparison with the Normal variety which was the shortest and seemed to be the more tolerant to spikes break.

d) *Number of leaves.* The changes in the number of leaves per plant in the different varieties followed closely the changes in tiller number. EL-MOURSI *et al.* (1963) found that the number of leaves of the uncut Westerwolds ryegrass showed a similar trend to that of tiller number. KAMEL (1959), obtaining similar results with barley, concluded that the increase in green leaf number per plant observed at the early stages of growth is due primarily to an increase in shoot number per plant and not to an increase in leaf number per shoot.

e) *Leaf area.* It could be indicated that the leaf area of the different varieties showed a similar trend to that of leaf number. Such result is in agreement with that obtained by EL-MOURSI *et al.* (1963) on Westerwolds ryegrass.

It is worthy to note that the leaf area of barley exceeded greatly that of ryegrass varieties during the early stages of growth up to 101 days after sowing. This might bear some inmpor tance in usingthese varieties for forage production.

f) *Dry weight.* The seasonal changes in the dry weight of root stems, leaves, spikes and the whole plant of barley and ryegrass varieties are illustrated graphically in Figs 1 and 2.

Roots. The dry weight of roots of barley plant continued to increase to reach a maximum 116 days after sowing, then showed a decrease till the end

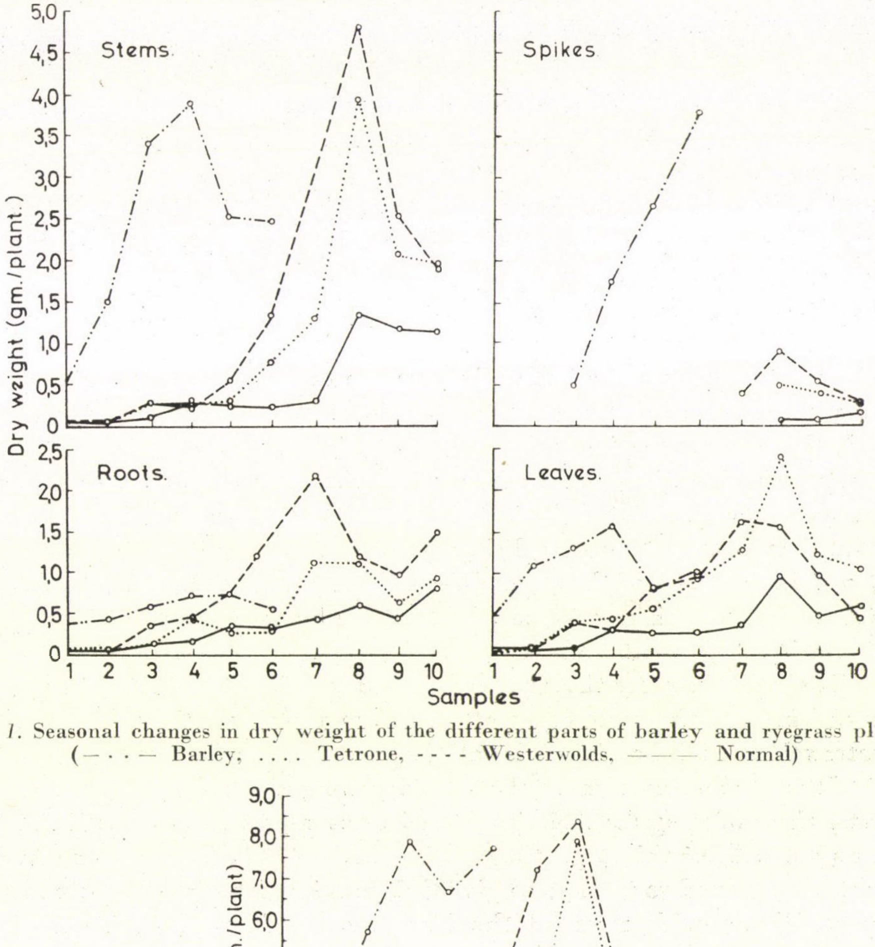

Fig. 1. Seasonal changes in dry weight of the different parts of barley and ryegrass plants (— · · — Barley, ... Tetrone, - - - - Westerwolds, ——— Normal)

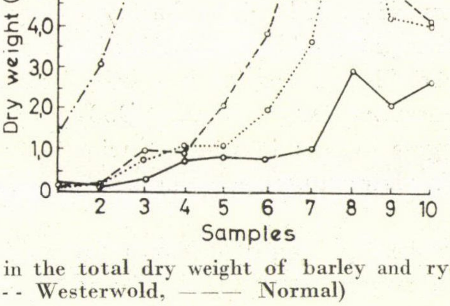

Fig. 2. Seasonal changes in the total dry weight of barley and ryegrass plants (— · · — Barley, ... Tetrone, - - - - Westerwold, ——— Normal)

of the experiment. This decrease could be mainly due to the maturing and dying off in the most absorbing roots, connected with top senescence. Similar results were obtained by KAMEL (1959). As for ryegrass varieties, Westerwolds and Tetrone showed nearly the same trend with the exception of a slight increase noticed at the last sample. On the other hand Normal variety showed nearly a continuous increase reaching its maximum at the end of the experiment.

It is clear that the dry weight of barley roots exceeded that of ryegrass varieties at the first samples. On the other hand, the latters showed their maximum dry weight of roots later at a time where barley plant ended its growth cycle, recording higher values than that obtained by barley. Comparing the three ryegrass varieties, it could be noticed that Westerwolds exceeded greatly the other two varieties in the dry weight of roots recording the highest maximum dry weight followed by Tetrone then the Normal variety.

Stems. The increase noticed in the dry weight of stems of different varieties at the first stages of growth might be due to the continuous accumulation of dry matter as these organs grew and increased in number. On the other hand, the decrease noticed at later stages might be attributed to the translocation of metabolites to the developing spikes as well as the death of some tillers as the plant approached the end of its life cycle. Similar trend was obtained by KAMEL (1959) with barley. RAAFAT *et al.* (1963) found that the dry weight of stems of the uncut Westerwolds ryegrass increased during the first stages of growth and decreased during the later ones, recording two peaks 107 and 142 days after sowing.

It could be noticed that the maximum dry weight of shoots of all varieties was obtained at the same dates of maximum tillering with the exception of Westerwolds which had it one month later.

It is interesting to note that the dry weight of barley stems exceeded greatly those of ryegrass varieties in their first stages of growth till 131 days after sowing. After this stage, the barley plant ended its life while the ryegrass varieties continued to increase to give their maxima later in the season. In this respect, Westerwolds recorded the highest value, followed by Tetrone then Normal varieties.

Leaves. The dry weight of leaves of barley and ryegrass varieties showed a similar trend to that obtained by stems. Maximum values recorded were far below those of stems. Similar results were obtained by KAMEL (1959) with barley. In this connection RAAFAT *et al.* (1963) found that the dry weight of Westerwolds ryegrass leaves increased during the first stages of growth, then decreased during later stage recording two peaks 107 and 142 days after sowing.

The results of the dry weight of leaves could be discussed similarly to that of stems. In this respect, AYERS (1936) found that the dry matter of dead cane leaves contained much lower concentrations of nutrients than that of green leaves. He concluded that these nutrients migrated from leaves to stalks before the leaves became physiologically inactive.

It is worth noting that the dry weight of barley leaves exceeded greatly that of ryegrass varieties up to 101 days after sowing following the results of leaf number and leaf area. Westerwolds and Tetrone varieties exceeded the Normal variety in the dry weight of leaves nearly throughout the whole season. These results might have some importance in using these varieties for forage production.

Spikes. The dry weight of barley spikes increased rapidly recording its maximum value at the end of the experiment. Similar results were obtained by KAMEL (1959).

As for ryegrass, the highest value was given by Westerwolds followed by Tetrone, then Normal varieties.

It is well known that, by the time of flowering and during seed development, reserved food materials in the leaves and stems are driven towards the spikes where they are mainly used by the developing seeds. This might contribute much to the increase noticed in the dry weight of the spikes as they grew and increased in number. The drop noticed in the dry weight of spikes of Westerwolds and Tetrone ryegrass varieties starting from 161 days after sowing till the end of the experiment could be mainly due to seed shattering (WHEELER 1950, HAUGES *et al.* 1952).

Whole plant. The trend of the total dry weight of the whole plant is the resultant of the behaviour of its component parts (Fig. 2). It is clear from the data that the dry weight of barley plant exceeded greatly that of ryegrass varieties during its life cycle. Meanwhile, the ryegrass varieties showed their maximum values in total dry weight later in the season. Westerwolds variety exceeded Tetrone almost throughout the season, whereas the Normal variety showed the lowest values. The maximum dry weight of the whole plant was obtained at the same dates of maximum tillering for all varieties with the exception of Westerwolds which showed its maximum dry weight a month later. The sharp decline noticed in the dry weight of Westerwolds and Tetrone plants was mainly due to the dying of the plant parts as well as the seed shattering noticed in these two varieties, as the plants approached the end of their life cycle. Such results are in full harmony with those reported by RAAFAT *et al.* (1963) with Westerwolds ryegrass.

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STUDIES ON SEED COAT AND SEED GERMINATION OF DESERT PLANTS

I. STRUCTURAL MAKE-UP OF SEED COAT IN SOME ASCLEPIADACEAE

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Structural make-up of mature seeds in four species of the family *Asclepiadaceae* has been correlated with their germination behaviour. *Leptadenia pyrotechnica* presents the weakest seed coat structure and following this was *Calotropis procera*. The seeds of *Pergularia daemia* possess some thickened hairs which cause some hindrance in water imbibition. *Cryptostegia grandiflora* did not present any complicated make-up, but the germination was preferred in total darkness. No hard seed coat dormancy existed in any of the species.

Introduction

In recent years, ecological life-histories of some desert plants have been undertaken by the author and his collaborators (SEN 1965, 1968a, 1968b, 1968c; SEN—CHATTERJI 1965, 1966a, 1966b; SEN *et al.* 1968). Some interesting features regarding germination of seeds have come to light during these studies. Some members of *Asclepiadaceae* are very conspicuous in the Indian desert regions which attract attention for the ecological studies on them. A start in this direction has already been made while studying the germination behaviour of seeds in *Calotropis procera, Cryptostegia grandiflora, Leptadenia pyrotechnica* and *Pergularia daemia* (SEN 1968c).

In this paper structural make-up of seed coat in the mature seeds of the four species mentioned above has been reported. It has been stated by a number of workers that generally the seed coats are hard and thus affect germination adversely. Hard seed coats play a very important role in the survival of a particular plant species, because the seeds are preserved as well as the germination is spread over for a long stretch of time (HARRINGTON 1916, CHAWAN—SEN 1968). Leguminous seeds are an example of this type. This may be the probable reason of the abundance of leguminous plants in this desert.

The structural make-up of the seed coat in the four species have been correlated with their germination behaviour. None of these seeds appeared to have hard seed coat dormancy as germination took place normally. However, their sensitivity to light and temperature has already been reported (SEN 1968c). This may be the reason why in spite of the enormous number of seeds produced every year, the number of new plants emerging from them has been observed to be rather small as compared to that of other plants such as of *Leguminosae* and *Gramineae*.

Material and Method

Most of the seed collections were made from the environs of Jodhpur (India) in 1965 and 1966. The mature seeds were kept in water for imbibition. They were taken out after imbibition but before germination actually took place as indicated by the protuberance of the radicle. The seeds were then pierced by means of a sharp knife so that infiltration may take place thoroughly. After conventional methods of dehydration and embedding, they were sectioned, individual sections being 12—16 μ in thickness and stained with safranin-fast green combination.

Results

Only mature seeds were selected for this study. The germination behaviour of such seeds had already been investigated. The structural make-up of the seeds have been described below separately for each species.

Calotropis procera (Ait.) R. Br.

The mature seeds of *Calotropis procera* were brownish grey in colour, flat with thin margins all around except at the micropylar end (Fig. 1 A). The seeds presented no difficulty in imbibition. It appeared that some breakdown of the seed coat walls took place as on an average one year old seeds indicated a higher germination percentage than the freshly collected ones within 24—48 hours (Sen 1968c).

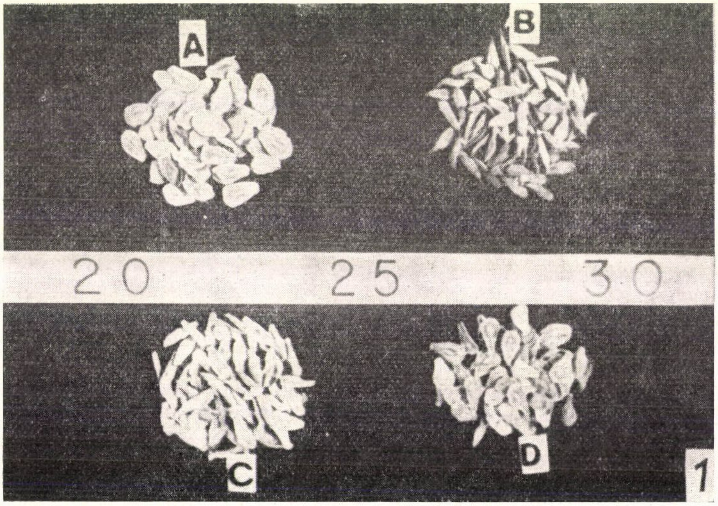

Fig. 1. Close-up of seeds of four members in *Asclepiadaceae:* A — *Calotropis procera*, B — *Cryptostegia grandiflora*, C — *Leptadenia pyrotechnica*, D — *Pergularia daemia*

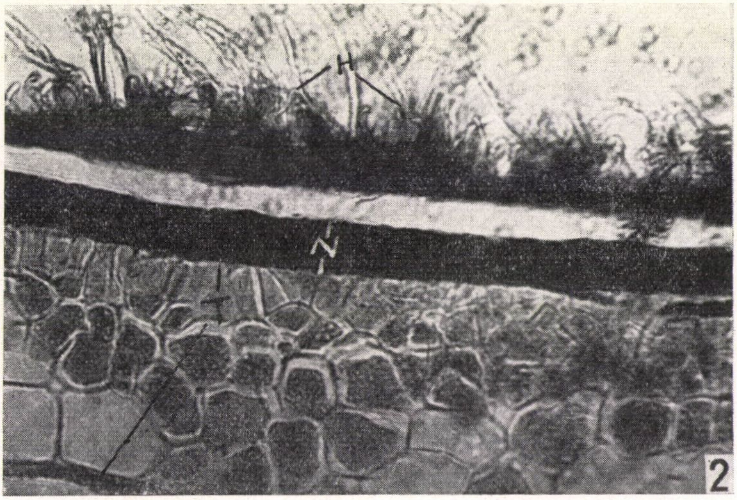

Fig. 2. Cross section of seed coat in *Calotropis procera* showing multicellular hairs (H), noncellular zone (N) and tegmen (T). ×320

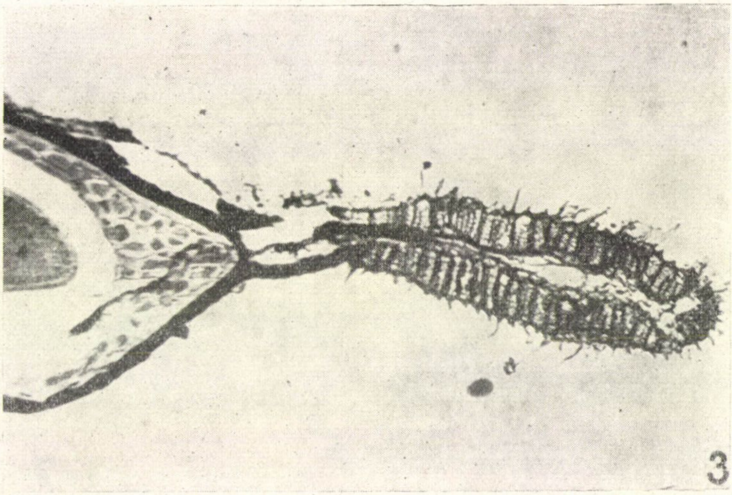

Fig. 3. Cross section of flattened margin of seed coat in *Calotropis procera* showing reticulately thickened rectangular cells on both lower and upper sides, ending in hairs. ×90

In a cross section (Fig. 2) the epidermis was observed to be present with abundant multicellular hairs followed by a brownish zone which appeared to be noncellular and had partly taken dark stain. The tegmen following this layer was 3—7 cells in thickness. The outermost one or two layers had smaller cells as compared to the inner ones. The cells appeared to contain storage products. The outer cells of the tegmen were more packed with storage materials than the inner cells.

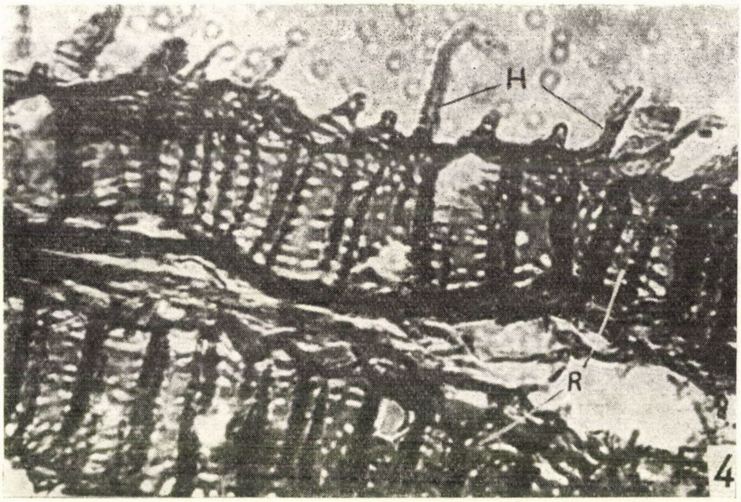

Fig. 4. A portion of Fig. 3 magnified to show reticulately thickened rectangular cells (R) ending outside in multicellular hairs (H). ×320

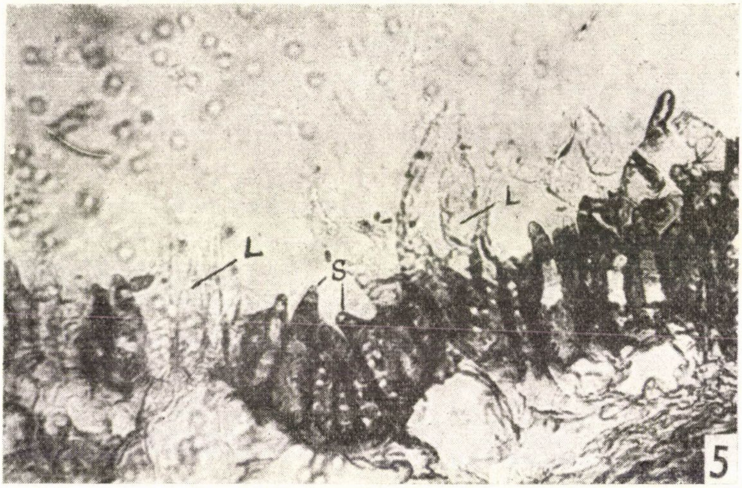

Fig. 5. Two types of hairs: small mostly three-celled and thickened (S) and longer with thin walls (L), and no distinct cells other than the basal one, in epidermal layer of the seed coat of *Calotropis procera.* ×150

At the flattened margins, there were thick-walled rectangular cells (Figs 3—4) both on lower and upper sides. These cells were reticulately thickened ending outside in multicellular hairs. These hairs were of two types (Fig. 5), small, mostly three-celled in height, with thick walls and the other was three to four times longer in height without any distinct cellular build-up other than

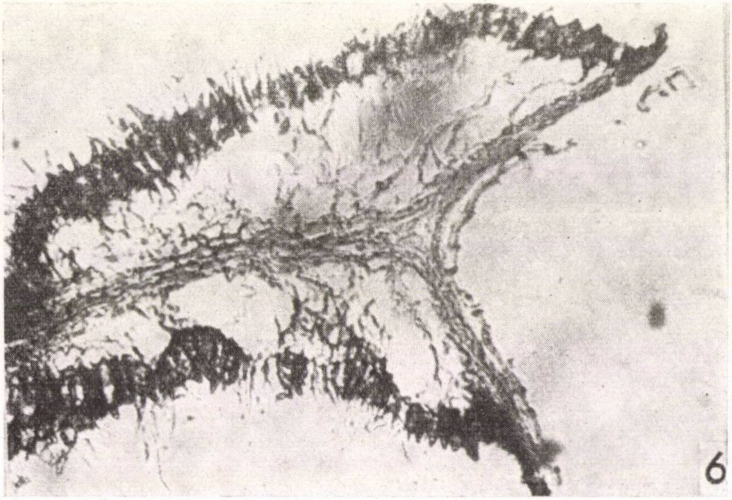

Fig. 6. Longitudinal section passing through micropylar region having thin-walled cells in *Calotropis procera.* ×150

the base and was thin-walled. Reticulately thickened cells were present on both sides with only thin-walled parenchyma in the middle.

The top of the micropylar end had thin-walled cells (Fig. 6). The reticulately thickened rectangular cells were as usual on the sides but intermixed with thin-walled cells. Some of the thick-walled hairs consisted of many or several cells. This thin-walled micropylar end appeared to be the weakest point allowing the entry of water at the time of germination.

Cryptostegia grandiflora R. Br.

The mature seeds of *Cryptostegia grandiflora* were brownish in colour. They were prominantly ridged on one side and so did not appear flat (Fig. 1 B). The seeds appeared hard and when kept in water did not quickly imbibe water, though cent per cent germination occurred at 30 °C in total darkness (Sen 1968c).

In a cross section (Fig. 7) the epidermal layer seemed to be made up of large cells filled with some sort of tanniniferous substances. Hairs of any kind, so prominant in the seeds of *Calotropic procera,* were absent. The slow imbibition of water might be due to the absorptive area being less in this case. The next layer beneath was the subepidermal layer, one to two cells thick of comparatively thin-walled cells. These cells are irregular in shape and the whole layer was less broad as compared to the epidermal layer, although the latter was constituted by a single layer of cells. The tegmen was very thick

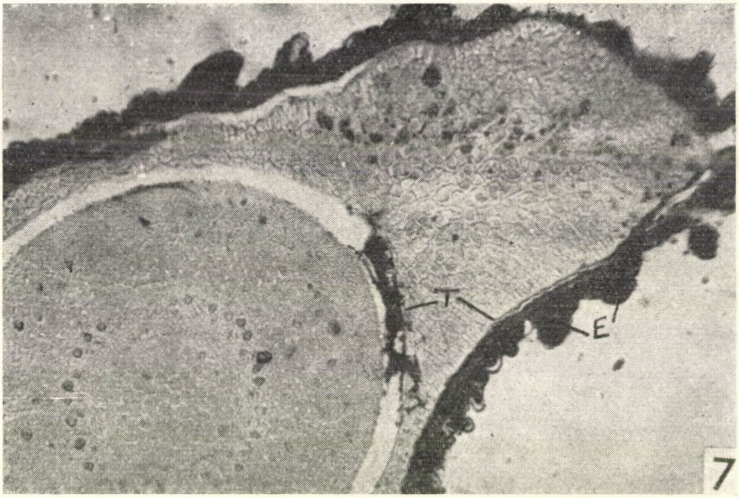

Fig. 7. Cross section of seed coat in *Cryptostegia grandiflora* showing smooth, but ridged epidermal layer (E) without hairs, and tegmen (T). ×90

Fig. 8. A portion of figure 7 magnified to show tannin-filled ridged epidermal layer (E), thin-walled subepidermal layer (SL) and tegmen (T). ×90

(20—25 cells) at the two sides (Fig. 7) and comparatively less so (7—10 cells) at the ridge on the upper and lower sides. In contrast to *C. procera,* in which two different types of cells inner and outer tegmen, such a distinction was not apparent in this case. The cells of the tegmen were ordinarily packed fully with the storage materials (Fig. 8).

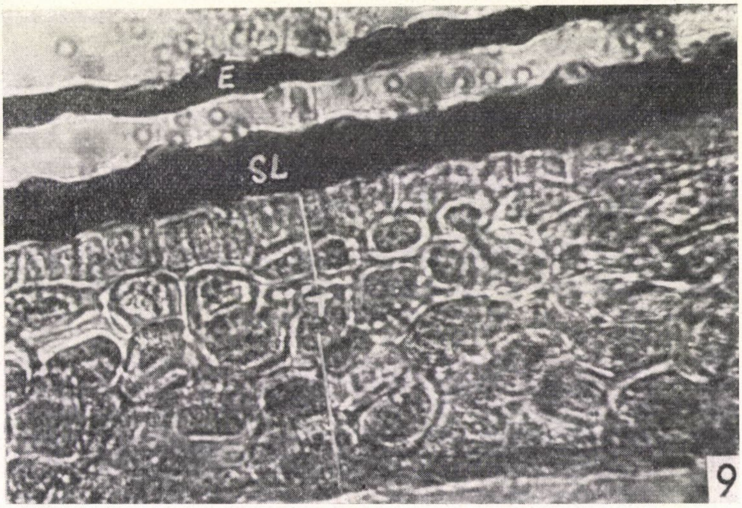

Fig. 9. Longitudinal section of seed coat in *Leptadenia pyrotechnica* showing disorganized epidermal layer of thin-walled cells without hairs (E), the subepidermal cells are comparatively thick-walled, red brown in colour (SL) and tegmen (T). ×320

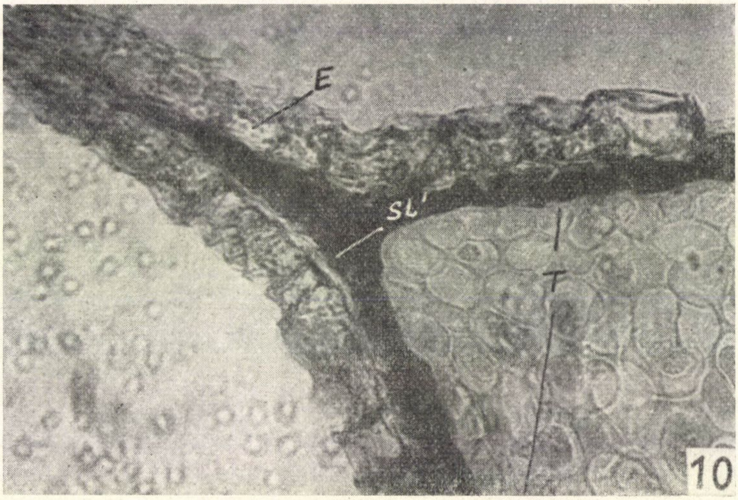

Fig. 10. Cross section of flattened marginal portion of *Leptadenia pyrotechnica*, showing thin-walled epidermal layer (E) without any reticulately thickened cells. The layers are epidermis (E), subepidermal layer (SL) and tegmen (T). ×320

Leptadenia pyrotechnica (Forsk.) Decne.

The mature seeds of *Leptadenia pyrotechnica* were yellowish grey in colour. They appeared to be most delicate as compared with the seeds of the other three species. They were flattened and smaller in breadth but were of the same length as those of *C. grandiflora* (Fig. 1 C). The seeds appeared to have a very thin and weak seed coat. They, therefore, indicated the highest germination percentage in the shortest time in almost any condition of light (SEN 1968c). The seed coat presented no hindrance to the imbibition of water.

In a cross section (Fig. 9) the epidermis which was single-layered appeared almost completely disorganized. This layer consisted of thin-walled cells without any kind of hairs. Beneath this was a red-brown coloured comparatively thick-walled layer which also consisted of disorganized cells as seen after imbibition. The tegmen was similar to that of other seeds and contained storage food products. At places there appeared to be some indication of division into inner and outer cells as was the case with the tegmen in *C. procera* seeds, but at other places this condition did not seem to exist.

The absence of hair and the presence of thin-walled epidermal layer without reticulately thickened cells at the margins all around (Fig. 10) seemed to be characteristic of *L. pyrotechnica* seeds. The latter, however, were very prominent in the seeds of *C. procera* (Figs 3 and 4). These weak layers led to a quicker germination of the seeds in the case of the *L. pyrotechnica.*

Pergularia daemia (Forsk.) Blatt. et McC.

The mature seeds of ***Pergularia daemia*** were very dark brown in colour. The seeds were flat with thin flattened margins which happened to be serrated all around (Fig. 1 D). The seeds appeared to present some difficulty in imbibition unlike those of *C. procera.* The seed coat appeared to be impermeable to water in the case of fresh seeds, though one year old seeds germinated to some extent (SEN 1968c).

In a cross section the epidermis, though not so well defined in imbibed seeds, appeared to consist of cells filled with some tanniferous substances. The hairs present were not many-celled and appeared twisted (Fig. 11). A much broader zone occurred beneath, which consisted of undefined thick-walled brownish red cells. All these offered hindrance to water imbibition. At the margins the cells were very well defined, thick-walled compactly arranged (Fig. 12) with distinct hairs. The tegmen was uniformly 5—7 celled thick but it consisted of a smaller number of cells on the margins. The distinction of inner and outer cells in the tegmen was altogether absent.

Relation of seed coat structure with germination. The most common cause of dormancy in the seeds appears to be the presence of a hard seed coat. The seed coat structure adversely affects the absorption of water in most of the seeds with hard coats. Most of the desert leguminous seeds possess very hard coats which are resistant to abrasion and at times covered with a wax-like layer.

None of the seeds of the four plant species studied possessed any anatomical structure which might inhibit the entry of water into the seeds. The seeds of *L. pyrotechnica* were characterized by the weakest make-up of the seed

Fig. 11. Cross section of seed coat in ***Pergularia daemia*** showing distinct twists in the epidermal hairs (H). ×500

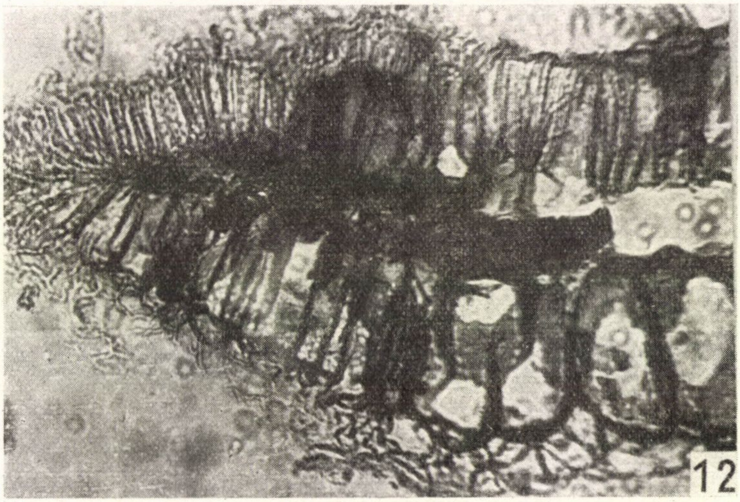

Fig. 12. Cross section of flattened margin in *Pergularia daemia* showing well defined thick-walled compactly arranged cells. ×320

coat and, therefore, the seeds absorbed water freely and germinated also in a shorter time as compared to the seeds of the other three species. The seed coat structure of *C. procera* was marked by the presence of fine hairs which were broken and were shed off in most cases. Water was thus absorbed through these broken points. The germination in this case was not hindered either because of the absence of any peculiarity of the seed coat structure. These seeds did not have a long viability period and the make-up of the seed coat helped quick germination.

The seeds of *C. grandiflora* were characterized by an altogether different epidermal structure which consisted of large or small cells, at times in the form of ridges. The epidermal cells were well filled with some tanniferous material because of which the seeds simulated possessing a hard seed coat structure. A cent per cent germination in this case took place in total darkness.

Pergularia daemia seeds had a very compact epidermal wall on the seed coat. The seeds though appearing similar to those of *C. procera* were different in the structural make-up of the seed coat. The hairs present were also different in nature than those of others in appearing twisted as a result of some sort of thickening. The hairs were long and did not appear to break off rapidly. The zone of undefined thick-walled brownish red cells was compact enough not to allow the inflow of water easily.

Discussion and Conclusion

Earlier workers in the field of ecology of seed germination did not emphasize the importance of the structural make-up of the seed coat. No such published work seems to be available on this subject as far as the author could make out. A number of methods have been tried to hasten germination in those seeds in which seed coat presented some sort of barrier to water imbibition and thus their germination. It would thus appear worthwhile to examine also the structural make-up of the seed coat in a mature seed. A knowledge of the seed coat structure would be of immense value in the ecophysiological studies on seed germination.

The mature seed coat varies greatly in form. It may be soft as in the case of seeds in most of the members of *Asclepiadaceae*, e. g., *L. pyrotechnica*. It may become gelatinous, e. g., the seeds of *Ruellia tuberosa* or hairy with mucilage, e. g., in the seeds of *Lepidagathis banderensis*. Fine hairs may also be present in many seeds on which they might be of minor importance, e. g., in the seeds of *C. procera*. A hard seed coat is the most commonly met with, e. g., in the seeds of *Sida* species (CHAWAN—SEN 1968) and *Ipomoea crassicaulis* (MISRA 1963) and in many of the leguminous seeds found in the deserts.

While comparing the observations made in course of the study of the seeds of four species of the family *Asclepiadaceae* with those of other seeds, it would be evident that none of the former were found to possess any structural peculiarity which might bring about inhibition of germination. The macrosclereids which happen to be a highly specialised layer in leguminous seeds has been found to be altogether absent in the seeds studied, the presence of which would normally make the seed impervious to water. The thickened twisted hairs in the seeds of *P. daemia* might hinder imbibition of seeds. In the seeds of *C. grandiflora* the structural make-up of the seeds did not appear to indicate any characteristic feature which might adversely affect their germination. But in these seeds, when they were kept in total darkness at 25—30 °C, germination rose up to one hundred per cent. It would appear that some biochemical change might occur in total darkness resulting in the breakdown of the seed coat structure leading to a high germination percentage.

The tegmen consisting of parenchymatous cells below the comparatively hard outer layer normally contained abundant storage product. This layer might be of some consequence in the seeds of *C. grandiflora* in which it happened to be comparatively thick. This tegmen has been found to swell and thicken abnormally under certain conditions in the seeds of *Euphorbia caducifolia* (SEN—CHAWAN 1968).

It has been reported earlier that the older seeds of *C. procera* germinate quicker than the freshly harvested ones (SEN—CHATTERJI 1965). It is considered as a rule that natural swelling of a seed in water begins at the micropylar opening. And in the case of the seeds of *C. procera* it has been shown that there was present opposite the micropylar opening a tissue formed of cells of extra thin walls. But it has been reported earlier (SEN—CHATTERJI 1965) that protrusion of cotyledons in these seeds also occurred at the chalazal end resulting in "chalazal germination", though the structural make-up of the seed coat happens to be such that for the tissues there to break or disorganize earlier than those at the micropylar end would be deemed rather inconceivable.

Thus it is not the structural make-up of the mature seeds of the four species studied which would possibly affect their germination; it is quite probable that other factors might be concerned in the process.

Acknowledgement

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NON-SYMBIOTIC NITROGEN FIXATION AS INFLUENCED BY SOIL MOISTURE

By

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The optimum level of moisture for the growth and proliferation of Azotobacter was found to be at 50—75 per cent of water-holding capacity in a clay loam soil. Clostridial counts increased as moisture increased, and the maximum count was recorded at 100 per cent of water-holding capacity.

Total nitrogen showed a marked increase at 25, 50 and 75 per cent of water-holding capacity. On the other hand, a marked loss was obtained at 100 per cent of water-holding capacity. However, the maximum gain of nitrogen was recorded at 50 per cent of water-holding capacity and coincided with the maximum rate of organic matter decomposition.

Introduction

Moisture governs all biological activities in the soil (ALEXANDER 1961, IBRAHIM 1964). This is essential for microorganisms since soluble ingredients enter the cells in the process of anabolism, and the by-products excrete away from the cells in the process of catabolism through water.

In Egypt, the soil is exposed to different levels of moisture throughout the year. It is usually water-logged for several months when cultivated with aquatic plants. In addition, flooding is normally practiced in Upper Egypt, before cultivating basin soils for approximately three months. On the other hand, when cultivating other economical crops, the soil is usually irrigated at short intervals in summer, since it is subjected to quick dryness due to the hot climatic conditions which promote drying up. In winter, however, the soil is irrigated at long intervals, due to the low temperature prevailing in such season. Further, soil is sometimes left fallow for a period which may extend for three months in summer; a procedure known as "Sharaqui" (IBRAHIM 1964).

Therefore, the soil appears to be subjected, either in summer or in winter, to different levels of moisture. Hence, it was found of interest to study the effect of soil moisture on the growth and activities of non-symbiotic nitrogen fixing organisms, namely *Azotobacter* and *Clostridia*. In this experiment a fertile clay loam soil was kept at different levels of moisture covering the most moisture contents that soils are normally subjected to.

Nitrogen fixing bacteria, however, are able to resist drying for a long period of time, depending upon the nature of the medium; the bacteria will resist desiccation longer in a rich clay soil than in sand (GILTNER—LANGWARTH 1916). HEINZE (1906) found that fallowing the soil led to an increase in nitrogen fixation, which was probably due to better aeration. KRAINSKY (1908) stated that nitrogen fixation took place in the soil when its moisture content was only 2 to 15 per cent. Excess of water, however, inhibited the action of *Azotobacter* and promoted that of *Clostridia*. The optimum moisture for nitrogen fixation was found by LIPMAN—BURGESS (1915) to be between 20—24 per cent. They, however, showed that air dried soils kept in stopped museum bottles for five to twenty years contained variable nitrogen fixing bacteria and manifested vigorous nitrogen fixing power. TRAAEN (1910) obtained a fixation of 1.9, 13.2, 16.6 and 15.5 mg nitrogen in 100 g of soil with 5—10, 17.5, 25, and 30 per cent moisture, respectively. LIPMAN—BURGESS (1915) found in many soils varying widely in physical conditions, two maxima for nitrogen fixation, viz., one 50—60 per cent and the other 70—80 per cent of water-holding capacity, and generally, fixation was low at 10, 20, 30, 40, 90, and 100 per cent of water-holding capacity. Similarly, insufficient moisture was found by TANATIN (1954) and ISHAC (1958) to be the chief factor in limiting the distribution and activity of Azotobacter.

Material and Method

Plastic pots 13 cm in diameter and 9 cm in height were used in the present investigation. Each pot received 200 g of fertile clay loam soil, obtained from the Experimental Station of the Botanical Section, Ministry of Agriculture at Giza. The soil was mixed with 2% (W/W) compost to raise its organic matter content, and thus enhancing the bacterial activities. Four percentages of water-holding capacities were kept during the experiment, namely 25, 50, 75, and 100%. The moisture content was kept constant throughout the experimental period by the daily weighing of each pot and the adding of water to compensate for loss due to evaporation. The pots were incubated at 30 °C for 10 weeks. Samples were carried out at 2-week intervals for microbiological and chemical analyses.

The counting of non-symbiotic nitrogen fixing organisms. Azotobacter were counted on Base medium 77 (ALLEN 1961), and *Clostridia* were counted on modified Winogradsky's medium (ALLEN 1961), using the dilution frequency method, after which the most probable numbers were calculated on the oven dry basis using HOSKINS' tables (1934).

Chemical methods. Walkely and Black wet digestion method was used for the determination of organic carbon, and Kjeldahl method was used for the determination of total nitrogen (JACKSON 1958).

Results

The initial count of *Azotobacter* was found to be 11.678 millions/g dry wt. of the soil. A significant increase was recorded in their counts at all levels of moisture after 2 weeks (Fig. 1). This could be deduced from the maintenance of moisture and the presence of available energy. Later, their counts showed a marked decrease, which can be deduced from the exhaustion of the available sources of energy. The highest count of *Azotobacter* was, however, recorded at 50 and 75 per cent of the water-holding capacity, being in the average of

72.148 and 52.139 millions, respectively. This indicates that the optimum moisture for the growth of *Azotobacter* is within these levels. In fact, the highest amounts of nitrogen fixed were obtained at these levels confirming this finding. Their counts showed a significant decrease at lower or higher levels of moisture above or below this range. However, counts at the low moisture content were higher than those at high moisture (27.296 and 16.416 millions at 25 per cent and 100 per cent of the water-holding capacity, respectively). This shows that high moisture content inhibits the growth and proliferation of *Azotobacter*. This inhibition could be attributed to the lack of oxygen, since *Azotobacter* is well known to be strict aerobe. Bisset—Hale (1953), however, stated that *Azotobacter* can evade the unfavourable conditions in the resting stage, viz. in the spore phase, as they took *Azotobacter* originated from the genus *Bacillus*.

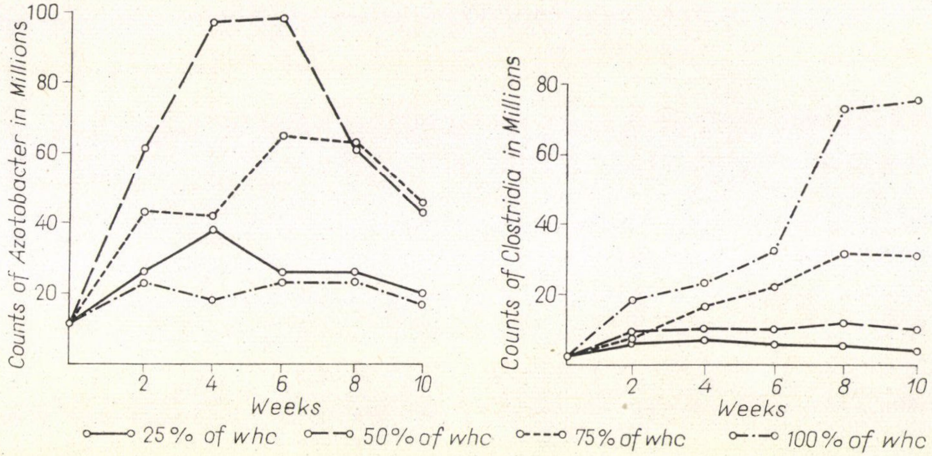

Fig. 1. Effect of soil moisture on *Azotobacter* and *Clostridia* counts in million per gm dry wt of soil

The anaerobic nitrogen fixing *Clostridia* were found to be in lower counts than *Azotobacter*. This, however, contradicts the results obtained by Waksman (1961) and Millar (1955) who stated that *Clostridia* were much more abundant in soil than *Azotobacter*. On the other hand, it confirms several Egyptian investigators (Abdel-Hafez 1962, Taha *et al.* 1965, Mahmoud—Taha—Ibrahim 1968).

In the present investigation, the initial count of *Clostridia* was found to be 2.442 millions/g dry wt. of the soil. An increase was generally recorded in their counts after 2 weeks at all levels of moisture (Fig. 1). This increase could be deduced from the presence of suitable moisture and available sources of energy in the soil. The highest counts were, however, recorded at 100 of the water-holding capacity being in the average of 42.569 millions. This can be deduced from the presence of low oxygen tension in addition to the organic matter, favouring the growth of *Clostridia*, since they are anaerobes. High moisture content in the presence of decomposable organic matter promoted the growth and proliferation of anaerobic nitrogen fixers occurring more or less dormant in appreciable number in aerated soils. On the other hand, the number of aerobic nitrogen fixers was increased by organic matter and decreased as a result of flooding.

Table 1

Effect of soil moisture on non-symbiotic nitrogen fixation

Moisture		Weeks					
		2	4	6	8	10	
25% organic matter	%	2.196	2.069	2.060	2.017	2.014	0.319*
Whc Total N.	%	0.151	0.151	0.154	0.157	0.158	
+ or − N.	g	—	—	+1.89	+3.28	+3.78	+1.79**
50% organic matter	%	2.186	2.078	2.010	1.956	1.897	0.436*
Whc Total N.	%	0.157	0.159	0.161	0.165	1.165	
+ or − N.	g	+6.98	+5.41	+5.32	+6.42	+5.14	+5.85**
75% organic matter	%	2.197	2.095	2.062	1.945	1.900	0.433*
Whc Total N.	%	0.152	0.156	0.157	0.166	0.166	
+ or − N.	g	+1.12	+3.62	+3.80	+6.66	+5.97	+4.23**
organic matter	%	2.036	2.022	1.997	1.986	1.947	0.386*
100% Total N.	%	0.147	0.147	0.145	0.145	0.146	
+ or − N.	g	−2.32	−2.21	−3.08	−2.98	−2.23	−2.56**

Initial organic matter = 2.333% on dry wt. basis.
Initial total nitrogen = 0.151% on dry wt. basis.
* Total amount of decomposed organic matter.
** Average gain (+) or loss (−) in total nitrogen per 100 g of carbon utilized.

The lowest counts of *Clostridia* were recorded at 25 per cent of the water-holding capacity being in the average of 5.555 millions. This relatively high count obtained at the low level of moisture, could be attributed to the symbiotic action as a result of the microbial association enhanced by the presence of organic matter causing more activities of these organisms. This resulted in the depletion of soil oxygen, furnishing suitable environments for *Clostridia* to proliferate.

When calculating the amounts of nitrogen fixed at all levels of moisture (Table 1), one could find that an increase was recorded in the total nitrogen during the experimental period ended with 0.158 per cent at 25 per cent of the water-holding capacity (the initial amount of nitrogen was 0.151 per cent). The same trend appeared also at 50 per cent and 75 per cent of water-holding capacity. However, the increase was relatively higher than that at 25 per cent of water-holding capacity being 0.165 per cent and 0.166 per cent, respectively. This shows that 50 per cent and 75 per cent of the water-holding capacity are within the optimum moisture for nitrogen fixation exerted by non-symbiotic nitrogen fixers. On the other hand, a loss was recorded in the total nitrogen at 100 per cent of water-holding capacity. In fact, the recorded figures represent the resultant of two factors: a) the gain in nitrogen fixation exerted by the anaerobic nitrogen fixers i.e. *Clostridia*, b) the loss due to denitrification and nitrate reduction, as a result of the anaerobiosis, due to the excess of moisture. The second process appears to have the upper hand of the first one as the loss was more pronounced showing minus figures than the initial content (0.146%), therefore, the fixed nitrogen appears to be masked.

By calculating the amount of nitrogen fixed per 100 g of carbon utilized (Table 1), there occurred a gain in nitrogen fixation at 25%, 50%, and 75% of water-holding capacity, being in the average of 1.79, 5.85, and 4.23, respectively. The maximum gain recorded at 50% of water-holding capacity denotes that this level is within the optimum for the non-symbiotic nitrogen fixation process.

Discussion

Moisture governs all biological activities in soils by two ways (ALEXANDER 1961). Water being the major component of protoplasm, an adequate supply of water must be available for vegetative development. But, as soon as moisture becomes excessive, microbial propagation is suppressed not by the over-abundance of water, which is not deleterious per se, but rather because the oversupply limits gaseous exchange and lowers the available oxygen supply creating thereby an anaerobic environment. RAHN (1912), however, showed that the influence of moisture upon the activities of bacteria is due to two factors: a) the penetration of atmospheric oxygen through the medium; b) therapidity of diffusion of the nutrients. He also added that a high moisture content is more favourable for bacteria, but it diminishes aeration.

In Egypt soils are exposed to different levels of moisture throughout the year as has been mentioned before. Thus, it is found of interest to study the effect of soil moisture on the growth and activities of non-symbiotic nitrogen fixing organisms, namely *Azotobacter* and *Clostridia*. Non-symbiotic nitrogen fixation is well known to be of great benefit to soil fertility specially in Egyptian soils, so many investigators have drawn the attention to the presence of high densities of nitrogen fixing organisms in such soils. The fixation of atmospheric nitrogen as microbial protein is, however, the cheepest means of soil manuring.

In the present investigation, a fertile clay loam soil amended with 2 per cent organic matter as compost was kept at different levels of moisture ranging from 25 to 100 per cent of its water-holding capacity. 50 and 75 per cent of water-holding capacity were found to be within the optimum range for the growth and activities of *Azotobacter*. Clostrial counts have, however, increased as moisture content has. This is expected, since they are anaerobes. The presence of low oxygen tension in addition to organic matter, has favoured the growth and proliferation of *Clostridia*. The data showed that the incidence of *Azotobacter* was at its highest at 50 per cent of water-holding capacity. As moisture was increased or decreased, their counts showed a marked decrease. This decrease was found to be very high at the high levels of moisture, indicating that *Azotobacter* could endure dryness (BISSET—HALE 1953). LIPMAN—BURGESS (1915) stated that many soils manifested a vigorous nitrogen-fixing power, even after being air-dried and kept in stopped bottles from five to twenty years. On the other hand, insufficient moisture was found by TANATIN (1954) and ISHAC (1958) to be the chief factor limiting the distributions and activities of *Azotobacter*. Still excess moisture seems to check their growth and proliferation. This may be due to the low oxygen tension prevailing under the high moisture content. HEINZE (1908) showed that fallowing the soil leads to an increase in nitrogen fixation, resulting from better aeration. TRAAEN (1910) also stated that the quantity of the present water might become so great that it would kill *Azotobacter* and inhibit nitrogen fixation.

When calculating the amounts of nitrogen fixed at all levels of moisture, it was found that the high proliferation of *Clostridia* at high moisture did not affect the amount of nitrogen fixed to the same extent as that of *Azotobacter*. This indicates that the rate of fixation by *Azotobacter* at its optimum moisture is significantly higher than that of *Clostridia* at its optimum moisture. Therefore, one could stress the importance of *Azotobacter* in Egyptian soils, and furnish the suitable habitat for their proliferation. The amount of fixed nitrogen was found to be in the positive side (+1.79 g) at the lowest level of moisture, whilst at 100 per cent of water-holding capacity, where the growth of *Clostridia* is at its peak, it was in the negative side (—2.56 g). This does mean that although the growth of *Azotobacter* was relatively low at the lower level of moisture, yet it fixed more nitrogen than *Clostridia* at its optimum moisture. Hence, it could be stated that the rate of nitrogen fixation by *Azotobacter* at its optimum moisture, is significantly higher than that by *Clostridia* at its optimum moisture. However, the extent of nitrogen fixation by *Clostridia* at the higher levels of moisture, may be masked by other deleterious processes such as nitrate reduction and denitrification.

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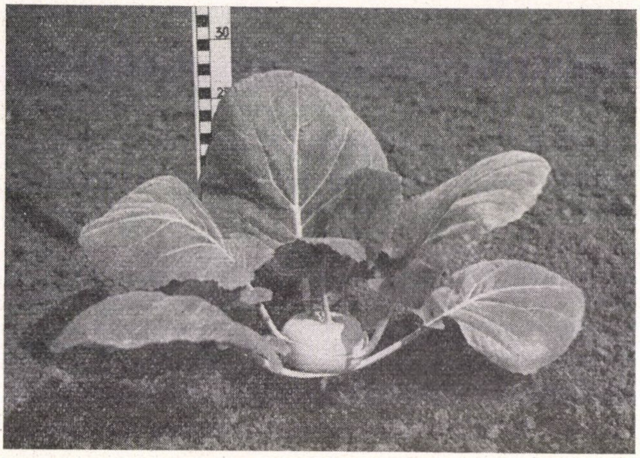
VARIA



WHITE KOHLRABI OF SZENTES

Taxonomical place: Brassica oleracea L. convar. *acephala* (DC.) Alef. var. *gongylodes* L. f. gongylodes

Origin: produced from a population of local variety by individual selection (Kapás *et al.* 1965)

Beginning of breeding: 1955, Szentes.

Breeder: Peter Szalva, Szentes.

State qualification: provisionally certified improved variety, 1961; state certified improved variety, 1967.

General characterization: cold-hardy, resistant kohlrabi of short vegetation period, with yellowish green tuber.

Morphological description:

Root system: fine, compact.

Shoot system: develops only in the second year; then the well wintered sets produce strong seed stalks; seed stalks are profusely branching. Stem developed in the first year below the tuber is a thin (4—8 mm diameter) but stable organ standing out of the ground.

Tuber: slightly flattened spherical, of 6—7 cm diameter when marketable, diameter along the longitudinal axis only 4.5—5 cm; its colour is light yellowish green, sometimes with a light purplish colouring. Somewhat sunken at the top. Flesh is fine, tender, of excellent quality.

Foliage: consists of scarce small leaves, but leaves are straight upright, so the rosette is closed. Leaves are generally 6—7 in number and their length (together with the petiole) is 18—24 cm, width 8—10 cm. Leaf blades are ovate, sometimes lanceolate-ovate; colour is light green (with a slight purplish tint).

Inflorescence: corymbs thickly loaded with flowers develop on caules only in the year of seed production. Flowers are light brimstone-coloured.

Fruit: brown silique of about 5 cm length.

Seed: spherical, smooth, blackish brown.

Biological characteristics:

Vegetation period: the tuberous plant develops in a short time; it can be harvested six weeks after transplanting. Harvest takes place 80—90 days after germination.

Development: quick and intensive.

Frost hardiness: tolerates — though not for a long time — even a temperature of 5 °C below zero.

Resistance to diseases: disease resistant.

Farm technology requirements: seedlings grown in hot beds have to be transplanted early, otherwise they do not give sufficient results. Seedlings are best raised in fostering soil. Optimum time of sowing is February, transplantation has to be carried out in March (GÁBRIEL 1962).

Productivity: according to the variety test (GÁBRIEL 1962) tuber yield per ha is 88, 6—107, 1 respectively. Average tuber weight is 108.5 g (ranging from 106—111 g). First harvest gives 11—25 per cent of the total tuber yield; 50—60% of the yield is harvested the second and third time of which 70—80% is graded as Ist and IInd classes (GÁBRIEL 1962).

Area of cultivation: can be grown all over the country either by forcing under glass, or with early transplantation.

*

Prepared by the National Institute of Agrobotany, Tápiószele

GY. MÁNDY

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PURIFICATION, AND PROPERTIES OF BULL SPERMOSIN

ENGELHARDT (1946) was the first to write down that the sperm contains a protein — since then called spermosin — showing ATP-ase activity. Owing to methodological difficulties ENGELHARDT—BURNASHEVA (1957) and BURNASHEVA (1958) did not obtain reliably pure preparations, therefore did not consider the enzyme data relative to the spermosin to be sufficient either. They found its molecular weight similar to that of the myosin of the skeletal muscle, while the shape of the molecule was found different. HOFFMANN—BERLING (1955) produced a fibre system similar to myofibrils from glycerinated sperm and by SZENT-GYÖRGYI's method isolated from it a myosin-like matter displaying ATP-ase activity which belonged to the system of fibres rising from the tail.

In the Electron Microscope- and X-ray Laboratory of the University of Agricultural Sciences, Gödöllő, ultrastructure, surface charge conditions and density distribution of inner material in the bull sperm were studied in the last ten years by **Veres** (1968, 1969). It was this study that inspired our investigations towards proteins playing a role in the movements of sperm. We set the aim of isolating spermosin of a degree of purity corresponding to that of myosin, identifying it and comparing its properties to those of the myosin.

Spermosin was produced by starting from a mixture of bull ejaculates. In our experiments 20—40 ml of fresh ejaculate derived from 3—8 bulls was cooled to 0—4 °C and diluted with cold 0.15 M NaCl solution to a 4—5 fold volume. The cellular elements were centrifuged at 3000 g (for 15 minutes) and the supernatant thrown away. The precipitate was suspended again to the former volume and washing repeated. Sperm washed out was mixed with 0.15 M NaCl of tenfold volume, pH adjusted to 7.6 with 20 mM Tris—HCl buffer, and the suspended sperm disintegrated with ultrasonic treatment (7 kilocycle, 10 minutes) to head- and tail parts. Ultrasonic treated suspension was centrifuged for 3 minutes at 300 g and the greyish residue containing the head part discarded. The procedure was repeated by centrifuging for 4 minutes at 400 g. The tail part was gathered from the opalescent supernatant by centrifuging for 20 minutes at 5000 g, then the supernatant discarded. The residue consisting of the tail part was found but occasionally to contain sperm heads and sperms injured during the procedure. On the basis of the muscle myosin procedure with **Szent-Györgyi**'s (1949) method modified by **Portzehl** *et al.* (1950) through a 10 minutes extraction process spermosin was produced from the precipitate containing the tail parts. Spermosin was precipitated diluted with distilled water to a ratio 11 : 1, and after the decantation the precipitate gathered by centrifuge for 10 minutes at 3000 g. After solution the spermosin fraction corresponding to actomyosin was precipitated by having been diluted to 0.26 M KCl concentration, and removed from the spermosin by centrifuging at 3000 g for 10 min. The spermosin was diluted to a concentration of 0.03 M KCl, precipitated again, gathered in a refrigated centrifuge at 3000 g for 30 min and soluted again in 0.5 M KCl to a concentration corresponding to 5—10 mg protein/ml.

The ATP-ase activity of spermosin was determined according to **Holland—Perry**'s (1969) technique in the presence of Ca or Mg ions respectively. The inorganic phosphate released by the activity was determined by the method of **Fiske—Subbarow** (1925), but the reduction was performed by the ascorbic acid method, modified by **Lowry** *et al.* (1954). The cholinesterase activity of spermosin was measured with **Hesterin**'s (1949) method. The protein content was calculated from ultraviolet absorption at 280 nm, and after Kjeldahl's method of total nitrogen determination. Chromatographic separation of spermosin was performed on a DEAE-cellulose column as described subsequently in detail.

When starting from 20 ml ejaculate we obtained an average of 10—20 mg spermosin purified twice by precipitation. Thus, with the view of continuing purification by chromatography at least 50 ml ejaculate should be used in order to obtain sufficient amount of protein for the examination of the isolated spermosin. The enzyme activity of spermosin differs from that of the myosin in the skeletal muscles of rabbits, since spermosin is activated both by Ca^{++} and Mg^{++} ions. Besides, the specific activity of similar fractions is also higher than that of the rabbit myosin.

	Released inorganic phosphate micromol/mg protein/min.		
	Ca^{++}	Mg^{++}	without ions
Spermosin	0.245	0.205	0.09
Myosin	0.210	0.000*	0.05

* non detectable

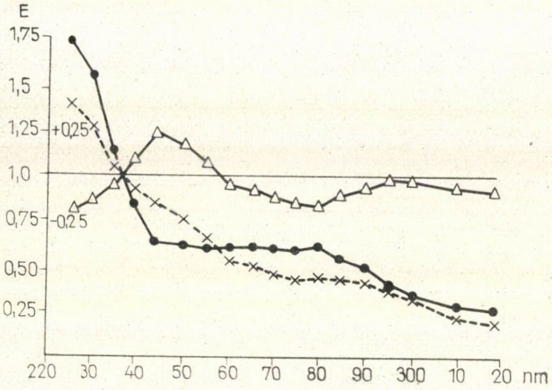

Fig. 1. Ultraviolet spectra and difference-extinction spectra of spermosin before chromatographic separation. .‑‑. at pH 7; × ‑‑× at pH 13; △ ‑‑△ difference spectra

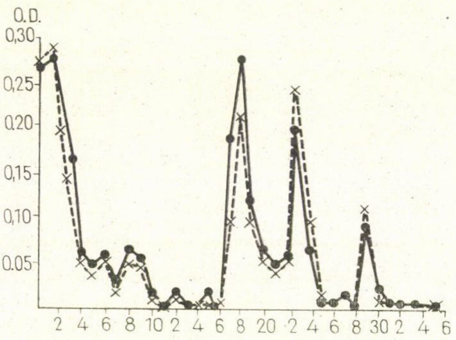

Fig. 2. Chromatography of the spermosin on the DEAE-cellulose column. .‑‑. E_{280}; ×‑‑× E_{260}

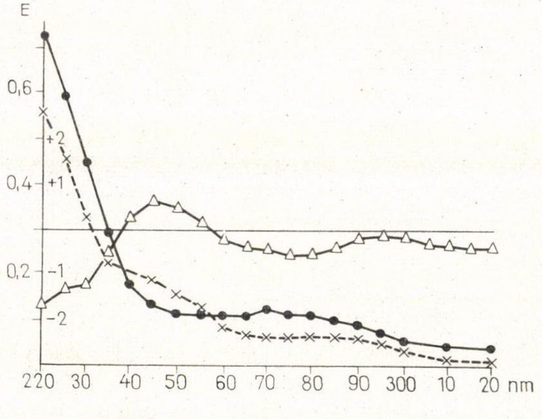

Fig. 3. Ultraviolet spectra and difference-extinction spectra of chromatographied spermosin. .‑‑. at pH 7; ×‑‑× at pH 13; △ ‑ △ difference spectra

ATP-ase activity of spermosin and myosin in the skeletal muscles of rabbits in the presence of Ca^{++} and Mg^{++} ions. Reaction mixture: 25 mM Tris—HCl (pH 7.6) 2.5 mM $CaCl_2$, or $MgCl_2$, 0.05 M KCl, 0.5—2.0 mg/ml protein, incubation at 25 °C (5 minutes) and reaction started with 0.5 mM ATP. Total volume is 2 ml. Stopped with 2 ml 20% TCA. Inorganic phosphate content determined from 2 ml filtrate.

The ATP-ase activity of spermosin is sensitive to detergents — similarly to that of myosin —; 0.2 mM dodecil-sulphate decreases the activity by 20% while 0.7 mM by 70—80%. The fraction corresponding to actomyosin — though containing a considerable amount of contamination — shows an ATP-ase activity of nearly the same extent as spermosin does.

Neither the spermosin nor the spermo-actomyosin have any acetyl-cholin-esterase activity. After 1 hour centrifugation at 105 000 g spermosin ceases to be opalescent and some precipitate can be found at the bottom of the tube, while a considerable amount of floccule on the surface of the spermosin solution. The latter contains much lipoid and little protein, while the precipitate at the bottom only a negligible amount of lipoid.

Spermosin when separated on a DEAE-cellulose column after Morey *et al.* (1967) gives no satisfactory result; the method was developed for myosin. Namely, on a column equilibrated with 0.04 M pyrophosphate buffer, spermosin dialysed against a buffer of the same concentration is bound only to about 30—40%, and the main fraction considered spermosin already eluates at the initial concentration of the NaCl gradient.

A satisfactory result was obtained with the following method. The spermosin was dialysed against 0.02 M pyrophosphate buffer (pH 7.6) and the DEAE-cellulose column (0.6 cm × 10 cm) equilibrated with phosphate buffer. This column is able to separate the total amount of 60—70 mg spermosin. The small amount of protein that cannot be bound has no ATP-ase activity. Elution is started with pyrophosphate buffer of 0.02 M which after a 4—5 fold column volume does not elute much matter. Then elution is continued with a buffer of KCl content as seen in Fig. 2. An amount of five column volume of elution solutions is enough when 10—20 mg spermosin is applied to the column. Fig. 1 shows the ultraviolet- and difference-extinction spectra of myosin applied to a DEAE-cellulose column.

On the chromatogram shown by Fig. 2 elution of spermosin occurs at peak IV. With fraction IV about 70% of the applied matter is eluted. Solutions prepared with higher concentrations of KCl up to 0.7 M do not elute more protein or any other substances. Therefore we perform elution with 1 M and 2 M KCl solution respectively which results lipids instead of proteins. Some 10—15% of the matter that remained on the column is obtained only during the regeneration of the column. We collected 2.1 ml fractions.

Percentage distribution of spermosin fractions and the quotients of E_{280}/E_{260} are presented in Fig. 2.

Fraction I — though displaying an ATP-ase activity — shows at least four components. 70% of the ATP-ase activity is displayed by fraction IV. Fractions V and VI have no ATP-ase activity and their protein content is insignificant. In the course of the elution the E_{280} E_{260} quotient rose considerably over 1.0 only in fraction IV and to a lower extent in fraction II. Its ATP-ase activity is not known due to its small amount. Rabbit myosin has ATP-ase activity at the place III too, but here it is absent.

Ultraviolet and difference-extinction spectra of fraction IV are shown by Fig. 3. The spectra shows hardly any difference from the non-chromatographied spermosin in Fig. 1, though its quotient has risen from 1.02 to 1.20. Namely, the fractions of spermosin contain little of aromatic amino acids as shown by the basic spectra and the difference extinction spectra. It is a high extinction value that corresponds to 1 mg protein. (1 mg: 2.21 E_{280} at pH 7, after Kjeldahl's protein values calculated from N content.)

Spermosin forms a complex with the skeletal muscle-actin of rabbits and its viscosity increases. Under the influence of ATP the viscosity shows a decrease of value in Ostwald's viscosimeter of 2 ml volume and 30 sec flow time. However, many data are still required for calculating and checking the specific values. Namely, spermosin shows a much lower specific viscosity than rabbit-myosin, which suggests that the shape of the molecule is different and may not be as asymmetrical as in the myosin.

The present paper describes the chromatographic elution of spermosin. The crude spermosin purified with repeated precipitation still contains much contamination and lipids. A part of the contamination can be removed by being ultracentrifuged (at 100 000 g, for an hour at 0 °C). Most lipids accumulate as floccules on the surface of the liquid, while a smaller amount of denaturalized protein precipitates at the bottom of the centrifuge tube. When separated on DEAE-cellulose column the ultracentrifuged spermosin gives more fractions. On the basis of activity measured 70% of the spermosin is contained in fraction IV, while according to the extinction value only 25%. From the DEAE-cellulose column in fraction I about 20% of the spermosin is eluted is lipoproteid. The 280/260 quotient of spermosin obtained by chromatography (fraction IV) rises from 0.98 to 1.20 during elution. The rise is the consequence of the removal of fractions V and VI. The two latter fractions are: lipid and fatty acids. The spermosin shows low intensity maximum and minimum both at pH 7 and pH 13 which suggests that spermosin may still contain some lipid that covers the ultraviolet absorption of aromatic amino acids. Indeed, during the lengthy process of spermosin dialysis some lipid can be concentrated and isolated from the dialysing liquid, while the ATP-ase activity decreases parallelly. Our investigations suggest that spermosin is a highly integrated molecule of complicated structure.

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*

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SOME OBSERVATIONS ON THE PERIDERM FORMATION OF BUD SCALES IN SYRINGA VULGARIS L.

As it is known the development of the periderm — which protects the older roots and stems as well as fruits against the environmental conditions — and lenticel — which performs ventilation — can be traced back to the activity of phellogen initiated in the epidermis, adjacent or still deeper tissue regions (**Artschwager** 1918, **Clements** 1935, **McDaniels** 1937, **Eames—McDaniels** 1947, **Wutz** 1955, **Esau** 1960, **Kaussmann** 1969). Phellem develops similarly in petioles at the end of summer, prior to the abscission of leaves (**Wylie** 1930), as well as at the abaxial side of bud scales. As to the latter, in addition to their biological functions and morphological features, their tissue structure was also described (**Schacht** 1856, **Trecul** 1853, **Mikosch** 1877, **Haberlandt** 1909).

With these results taken in consideration the authors carried out examinations on *Syringa vulgaris* L. with the aim of acquiring a better knowledge of the development of bud scale periderm or analogous tissues.

For this purpose *Syringa* buds of various developmental stage were embedded in paraffin with the usual microtechnical procedure, and details studied on microtom section series. Microphotos were taken of certain characteristic stages in development.

On the young vegetative shoots of *Syringa vulgaris* several weeks after their development — generally at the end of April or beginning of May — there starts a differentiation of the next year's leaf- and mixed buds. On the earliest (lowest) nodes rudimentary leaves, the well-known bud scales appear crosswise, in an opposite position and covering each other. Somewhat higher, on the next fourth, fifth and sixth nodes, the blades of leaf-primordia are already larger. Further primordia can be examined only with preparation, they have young petioles too. At an early stage all bud scales are green just like the young stem axis. In early June the stem axis begins to become brown, and somewhat later the same process can be observed on the young buds too. This process of browning starts on the lower bud scales, at their abaxial sides, then the same can be observed on the bud scales of the next nodes too. Dissected buds reveal, however, that only the free upper third of the upper bud scales gets brown at the abaxial side, while basal parts covered by the lower bud scales remain green. Bud scales of the fifth and sixth nodes show only small brown spots at the tips. On the other hand, primordia of the typical future foliage leaves remain totally light green under the covering bud scales (Fig. 1).

Turning to the histological examinations, quite young and completely green bud scales are first described. Bud scales are covered with epidermis consisting of small cells, at the adaxial- and abaxial sides equally. At the abaxial side a thick cuticle develops which appears in a thinner layer on the upper scales. The mesophyllum is of homogeneous structure, its square cells are meristematic. Procambial differentiation of the vascular tissue has just started. As to the tissue structure there are some differences between bud scales covering each other.

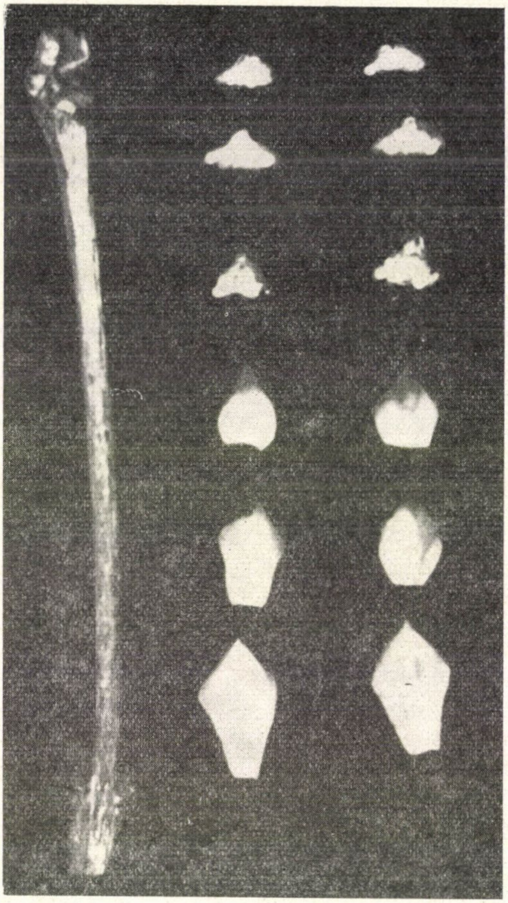

Fig. 1. Part of a *Syringa vulgaris* shoot with buds. Bud scales separated from the bud; The sequence of development of the bud scales is advanced from upward to down. (N = 1 : 2)

Mesophyll of the lowermost bud scales consists of 24—25 cell layers. Higher up, bud scales at the fourth node are 13—14 cell-row thick, while those at the sixth node as well as foliage leaf primordia have a mesophyll with 11—12 cell rows.

When the stem axis begins to become brown important cytological changes occur in the bud scales too. In the lower bud scales, at the abaxial side, in the mesophyllic cell-row adjacent to the epidermis maturation of cells decreases, then a plasma accumulation starts followed by nuclear division with central spindle perpendicular to the surface, and periclinal cell wall development (Fig. 2). In a short time this cell division takes place in groups consisting of 3—4 cells (Fig. 3). Among the developing cells the outer one grows radially, becomes gradually constant and develops vacuoles, while the inner one soon divides again. Out of the two new cells the outer one becomes constant again, while the inner one maintains for a while its ability to divide. So 3—4 cell-rows develop outwards (Fig. 4). A corky matter settles in the walls of these cells, in the course of their differentiation shown by a red colour produced with Sudan III treatment. Under the influence of Ehrlich's haematoxylin this cork tissue shows a slight

Fig. 2. Part of a *Syringa vulgaris* bud scale (first node) from the adaxial side. *e* epidermis; *m* mesophyll; *cu* cuticle (480×)

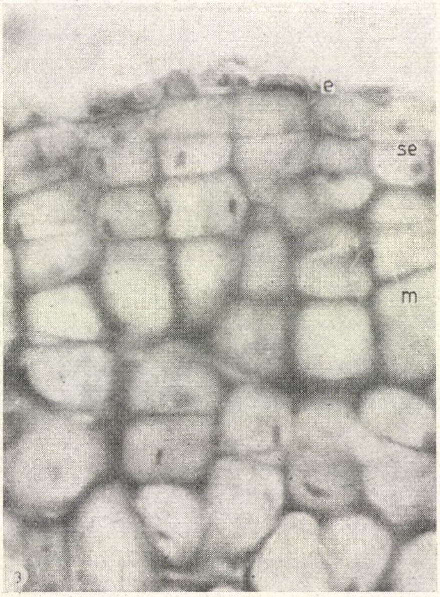

Fig. 3. Subepidermal development of phellogen at the adaxial side of the bud scale. *e* adaxial epidermis; *se* subepidermal layer (480×)

colouring, so it can be well distinguished from both the phellogen and mesophyll. Above the developed periderm there remains the epidermis, with the rather thick cuticle even when the bud scales are fully developed (Fig. 4).

The development of phellogen, and with it a process of de-differentiation and re-differentiation similar to the former one do not take place, especially towards the tips of the

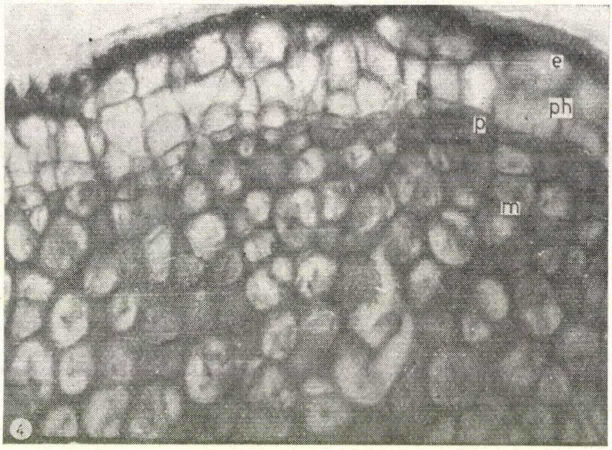

Fig. 4. Part of periderm in a bud scale developed at the second node. *e* epidermis; *ph* phellem; *p* phellogen; *m* mesophyll

Fig. 5. Periderm at the side of the lowest bud scale *(pe)*, cells in the apical part *(a)* became suberized (160×)

lower bud scales. Starting from the tips of bud scales mesophyll cells become intensively vacuolized, the plasma with the chloroplasts is restricted to the side of the cell-wall, and the development of the cell-wall changes. Under the influence of Ehrlich's haematoxylin, with which the section series were stained, cell-walls of these cells showed no colouring, on the other hand, the Sudan III treatment produced a red colour. Such suberization of cells — analogous with the exoderm — advances basipetally and meets the parallelly developing periderm tissue at the middle of the leaf (Fig. 5). The tissue region of the mesophyll above the periderm is built of cellulose-walled and chloroplast-containing parenchyma.

In the bud scales of the upper (3—4) nodes — as it has been already mentioned — browning occurs only on the free apical part, at the abaxial side. The basal part covered by the bud scales of the lower nodes is covered with epidermis even after full development. In the apical part of bud scales, in the subepidermal cell-row of the mesophyll the cells regain their ability to divide and act as a phellogen (Fig. 6). By unipleural division they develop a phellem of 3—4 cell-rows under the cuticle-covered epidermis.

Sometimes in the bud scales of upper nodes phellogen developed in the direction of stomata contained by the epidermis produces loose filling cells instead of producing phellem.

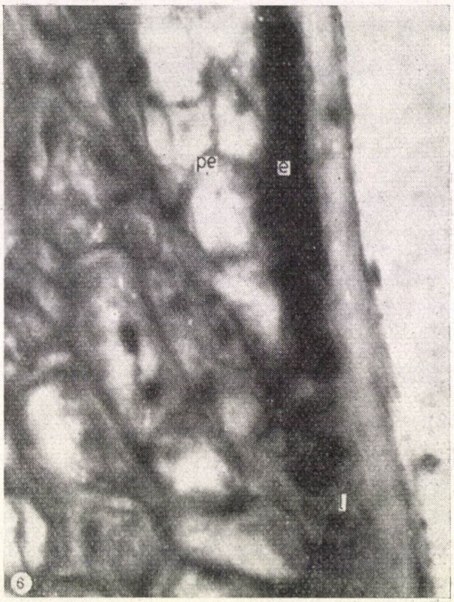

Fig. 6. Part of a bud scale at the fourth node. Below only epidermis *(e)*, higher up periderm *(pe)* and epidermis *(e)* (460×)

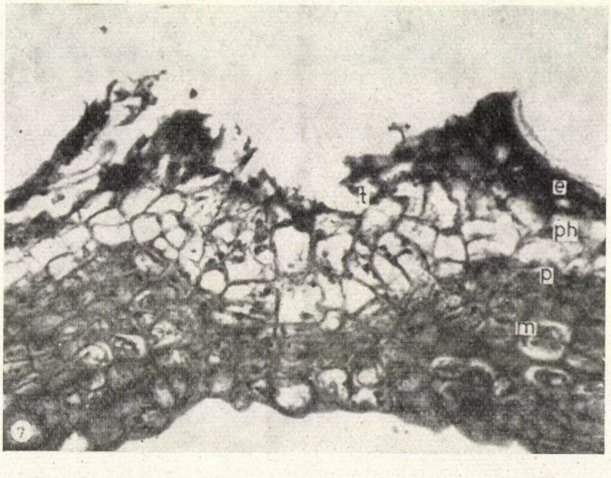

Fig. 7. Part of lenticel and periderm from a bud scale at the fourth node. *e* epidermis; *ph* phellem; *p* phellogen; *m* mesophyll; *t* filling cells (320×)

These cells press the epidermis outwards which first protrudes, then bursts and develops lenticels of rather regular structure. Later they become organically connected with the simultaneously developed phellem (Fig. 7).

Summing up the results of the examinations it can be established that the lowermote bud scales of Syringa vulgaris buds are covered mostly with periderm at the abaxial side, whis on the apical part — in the course of formation — cells become suberized analogously with the exoderm. Basal parts of bud scales at the upper nodes which are covered by the lower buld scales remain covered with epidermis, but in the free leaf blade periderm develops and, in addition, lenticels are produced. In the apical part of these leaves suberization in the cell-walls of matured cells can also be observed. Covering of the upper bud scales first with epidermis, and then with periderm shows the direct influencing effect of environment manifest even in such tiny organs.

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REACTIVATION OF DIAPAUSING LARVAE OF CARPOCAPSA POMONELLA L. (LEP.: TORTRICIDAE)

One of the basic requirements of a world-wide introduction of genetical control methods against major pests is to elaborate an artificial laboratory mass-rearing of the individual species. The first precondition of the elaboration of mass-rearing method is the precise knowledge of ecological factors regulating the evolutionary course of the species. As regards *C. pomonella* Bognár (1962), Russ (1966), Jermy (1967) and Wildbolz—Riggenbach (1969) — to mention only the most important authors — carried out detailed ecological examinations.

In our investigations the reactivation of *C. pomonella* larvae retiring to diapause at different times was studied. Our experiments were aimed at determining the time when laboratory rearing of larvae diapausing in the open field can start. By this the time of beginning of the laboratory mass-rearing can also be determined.

To start the laboratory mass-rearing of *C. pomonella* as early as possible it is very important to know the duration of diapause required for the reactivation of larvae diapausing in the open field. To clear this question, diapausing larvae collected in summer and stored in Jermy's wintering cage in the open air were placed for different periods in a thermostat of 23 °C temperature. Results are summarized on Table 1.

Among the data of the table the number of days between the time of placing larvae in the thermostat and the time of a 50 per cent appearance of imagos is the most suitable to be the basis of evaluation. Three groups can be distinguished accordingly: 1) population originating from larvae placed at 23 °C on 15th September, 2) between 1st December and

Table 1

Data of a reactivation experiment on diapausing larvae of C. pomonella

Time of placing larvae diapausing in an open-air-cage at 23 °C temperature	First	Last	50 per cent of imagos appeared	Number of days of swarming	Time of taking off the cater-pillar catching belts
	imago appeared				
September 15	Dec. 21. 97 days*	Febr. 7. 145 days	Jan. 17. 124 days	48	Aug. 26.
December 1	Jan. 3. 33	Febr. 8. 69	Jan. 31. 61	36	Aug. 18
December 18	Jan. 16 30	Febr. 19 64	Febr. 7 52	34	July 27
January 4	Febr. 18 36	March 18 75	Febr. 29 57	39	July 6
January 16	Febr. 17 33	March 25 70	March 11 56	37	July 13—27
February 1	Febr. 21 20	April 9 68	March 18 46	48	July 27
February 15	March 6 21	April 16 62	March 27 42	41	July 27
March 1	March 21 20	May 7 68	March 27 27	48	July 5
March 18	April 5 19	May 14 58	April 11 25	39	July 13; Aug. 5
April 1	April 13 13	April 26 26	April 17 17	13	July 6; Aug. 11
April 16	April 26 10	May 13 28	April 29 14	18	Aug. 11; Aug. 18

* Number of days from the time of placing larvae at 23 °C temperature

15th February and 3) after March 1. It is very interesting that there is hardly any difference in the duration of swarming among populations placed in the thermostat before April 1.

From the point of view of starting mass-rearing these results show that reproduction of diapausing larvae kept in the open field has to be started at the beginning of December.

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THE BIOMETRICAL DETERMINATION OF THE PROPORTIONS OF AGROTECHNICAL AND NATURAL FACTORS ON A MODEL OF ALFALFA SEED PRODUCTION

From the point of view of productivity we considered it very important to determine the proportions of the two groups of factors (agrotechnical and natural) which are of decisive importance in alfalfa seed production. For the purpose of a comparative evaluation of proportions of factors influencing the trends of yield, averages per cadastral yoke (0.65 ha) were expressed both in a linear equation and a power function on the basis of data obtained from farms.

The mathematical analysis based on biometrical calculations (Sebestyén 1962, Sváb 1967) was — in essentials — related to alfalfa seed production as a model. The mathematical analysis was aimed at determining which of the two groups of factors (agrotechnical and natural) had a greater influence on the per cadastral yoke yield averages.

Biometrical surveying was carried out in five counties of the Great Hungarian Plain, in 38 cooperative farms, by using questionnaires with predetermined questions. Prior to processing data were controlled from more than one side. The factors studied can be divided into two groups:

I. Quantitative factors

1) The pH-value of the soil, 2) number of rainy days at the time of mass flowering, 3) number of hot days with temperatures over 30 °C-at the time of mass flowering, 4) yield average of wheat (q/cadastral yoke), 5) amount of precipitation 2 months before harvest, in case of the second growth, 6) amount of precipitation 2 months before harvest, in case of the third growth, 7) percentage of alfalfa area to total arable, 8) number of days between mowing and dusting the stubble field, 9) number of animal pests found in 20 units, 10) per hour average speed of combines when harvesting (km/hour).

II. Qualitative factors

1) The dodder control, 2) chemical weed control, 3) hand netting, 4) application of attracting zones (in 1967), 5) defoliation (in 1967), 6) harvesting method (one- or two-course), 7) preparation and fulfilment of a plant protection plan, 8) which of the growths (second or third) produced the seed, 9) skill, 10) importance of soil map.

By the mathematical analysis of the effects of the 10 quantitative factors we wanted to attain a double aim:

1) to determine the extent to which the individual factors influenced the yield amount per cadastral yoke of seed production,

2) to determine which of the two groups of factors (six natural and four agrotechnical) has a greater influence on seed production.

When examining the effects of the 10 qualitative factors, 2 variants each of 8 of the 10 examined factors were studied.

The ratio between the effects of the two groups of factors was expressed both with a linear equation and a power function. In both cases we started from a multiple regression equation containing six and four independent variables derived from the six natural and four agrotechnical factors respectively. The natural factors (R_t) and agrotechnical values (dependent of human will R_m) were compared in the ratio of the squares of multiple correlation coefficients ($R_t^2 : R_m^2$).

The multiple correlation coefficients obtained with the two methods of calculation proved significant in every case. There was a minor difference found between the two years examined. The 1967 data showed a closer correlation than those of 1966. It is remarkable that the R values of the four (human dependent) agrotechnical factors were in both years considerably higher than those of the natural factors with both methods. This suggests that agrotechnical factors have a much greater influence on alfalfa seed production than the factors of nature, as indicated by the hundredfold squares of R-values contained in Table 1. These percentage values show the extent to which the factors examined — together and in groups — influence the trends of the per cadastral yoke yield.

Results obtained confirm our earlier hypothesis, namely, that agrotechnical factors and professional skill play a more important role in the success of alfalfa seed production than the factors of nature. On the supposition that the effects of the factors examined are nearly the same, and their being divided into groups of 4 and 6 respectively is accidental, regression analysis calculated with 6 factors shows a closer correlation than agrotechnical analysis calculated with 4 factors. Table 2 sums up the partial correlation coefficients with all the 10 factors examined taken into consideration together. As regards the multiple correlation coefficients

Table 1

Squares of multiple correlation coefficients $R^2 \times 100$ = percentage determination coefficients

Factors		Linear		Power function	
		1966	1967	1966	1967
10 together	R_{10}^2	68.7	81.5	65.9	85.9
6 natural	R_t^2	32.4	47.8	27.8	48.0
4 human dependent	R_m^2	53.1	74.0	54.7	78.3
$R_t^2 : R_m^2$		38 : 62	34 : 66	39 : 61	38 : 62

the data show a very close relationship between seed production and the 10 factors. It must be emphasized that the values of the multiple correlation coefficients calculated with the two different methods (linear and power function) corresponded with each other.

Table 2

Coefficients of partial and multiple correlations between seed production and agrotechnical factors
($F_{5\%} = 0.367$ FG = 27 38—1—10)

Factor	Linear		Power function	
	1966	1967	1966	1967
1 pH-value of soil	—0.150	—0.157	—0.052	—0.053
2 Number of rainy days at mass flowering	—0.496*	—0.383*	—0.373*	—0.401*
3 Number of hot days over 30 °C, at mass flowering	—0.045	0.188	—0.001	0.186
4 Yield average of wheat q/cadastral yoke	—0.342	0.098	—0.232	0.172
5 Precipitation 2 months before harvest, with the second growth	—0.299	0.289	—0.287	0.414*
6 Precipitation 2 months before harvest, with the third growth	—0.362	—0.303	—0.147	—0.462*
7 Percentage alfalfa area to total arable	—0.133	0.002	—0.141	0.008
8 Number of days from mowing to stubble-field dusting	—0.615*	—0.596*	—0.565*	—0.578
9 Hand netting	—1.124	—0.208	—0.092	0.037*
10 Combine speed (km/hour) when harvesting	—0.184	—0.346	—0.152	—0.474
R	0.829*	0.812*	0.812*	0.927*
F ($F_{5\%} = 2.20$)	5.915	11.935	5.223	16.443*

Among the 10 factors examined those that proved to be significant in relation to seed production are the following: 1) number of rainy days at the time of mass flowering, 2) amount of precipitation 2 months before harvest in the case of the second growth, 3) the same, in the case of the third growth, 4) number of days from mowing to dusting the stubble-field, 5) per hour speed of the combine when harvesting.

It is necessary to point out that such an extensive biometrical analysis of quantitative and qualitative factors is unprecedented in the world literature. The new method of evaluation was made possible by the use of computer. On the basis of our model of alfalfa seed production it is highly probable that in the case of a survey performed with other cultivated plants using the same method the agrotechnical factors and professional skill together will again prove superior to the factors of nature. Concerning the mathematical model obtained by biometrical surveying in large-scale farms it is necessary to note that the analysed 38 cooperative farms cannot be considered as a many-factorial experiment with 38 plots. Namely, the different levels of the 10 qualitative factors are irregularly combined in the individual farms, that is why their effects cannot be evaluated by a variance-analysis appropriate to the many-factorial design. Owing to the irregular (non-orthogonal) combination of the levels of the factors, the result of a one-by-one examination on the effects of the different factors may also contain the effects of one or more factors, without giving information on the quantitative, correlative extent of these effects.

The higher effectivity of agrotechnical factors playing a part in alfalfa seed production is the first evidence of the biometrical data which emphasizes the decisive importance of professional skill as compared with the factors of nature.

The great number of literary data on alfalfa seed production (BOLTON 1962, KEMENESY—MANNINGER 1966, VIRÁNYI 1964, 1967) do not make any suggestion of agrotechnical application of professional knowledge being superior to the natural factors as regards productivity. Thus the mathematical model has given a new possibility to evaluate correctly the importance of human dependent agrotechnical factors on the basis of multi-factorial analysis.

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THE FRIENDSHIP OF KEPLER AND A. SZENCZI MOLNÁR

Friendship is one of the highest social relations of man which exercises a decisive influence on the development of both individual and society. It is impossible to list all the results our nation owes to the friendship of other nations or to one or another of their great sons.

It is becoming more and more clear that a true and profound friendship between nations which also manifests itself in their members is an indispensable condition for the survival of mankind.

The present paper reports on the friendship of two great scientists, who, at the beginning of the 17th century, in 1604 and 1605 in Prague, the centre of the politically and religiously divided Europe, amidst wars gave testimony through the very fact of their friendship to the united European spirit, to the cultural and friendly relations of neighbouring nations.

These two scientists belonged to those who not only promoted the development of their nations and the whole of mankind with their ideas, discoveries and creative work, but also set an example of noble human attitude.

Johannes Kepler (1571—1630) was an epoch-making German astronomer and mathematician. During his studies he became the follower of Copernicus. He was appointed to a professorship in Graz. When the counter-reformation gained ground Kepler had to leave Graz owing to his ideas. From 1601 he worked in Prague as a collaborator and close friend of Tycho Brahe whose acquaintance he had made through his early work: *Mysterium cosmographium* (1596). In this work he already expressed his conviction about certain laws controlling the solar system. After Tycho Brahe had died Kepler was appointed court astronomer and mathe-

Fig. 1. Portrait of Johannes Kepler. After a lithograph published in Kepler J. (1866): Opera omnia, vol. VIII

matician to emperor Rudolph II. After Rudolph's death he became professor at the University of Linz. It was Kepler who discovered the three most important laws of planetary motion.

1. Planets move around the sun on elliptical orbits. The sun is in one of the focuses. 2. The main radius (the straight line connecting the planet with the sun) moves over equal areas in equal times. Thus planets move on their respective orbits with a higher speed when near the sun, and with a lower speed when far from it. 3. The squares of the planets' periods are in the same proportion to one another as the cubes of their average distances from the sun, — by which he perfected Copernicus' heliocentric picture of the world. His results concerning this thesis are contained in his two main works: *Astronomia nova* (New astronomy, 1609) and *De harmonice mundi* (On the harmony of the world, 1619).[1]

The Allgemeine Deutsche Biographie described Kepler's human characteristics in the following way: "He was a man who always wanted the best and the noblest and who never — not even under terrible blows — lost completely his optimistic view of life which was due both to his true philosophical way of thinking and profound religiousness."[2]

The other great scientist is Albert Szenczi Molnár (1574—1639), the Hungarian linguist, teacher, publisher, pastor and schoolmaster.[3] In one sentence we can best characterize him by saying: "He was a scientist urged by an incessant restlessness to raise the national cultural

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[1] Új Magyar Lexikon.
[2] Leipzig 1882. XV. vol.
[3] Magyar Életrajzi Lexikon. Dézsi op. cit. p. 4.

level."[4] At the age of 16 he went to Heidelberg and from that time on never stopped studying; he always remained a slave of books and a humble servant of publishing. According to one of the most thorough investigators of his life: "It would be difficult to find another Hungarian writer travelling abroad to whom the sources of culture and science revealed themselves to such an extent and who made the best of this opportunity throughout his life."[5]

His path was not easy to walk on. He almost became a legendary figure of migration and hardship.[6] He himself spoke of this: "Far from home, poverty-stricken he suffers from ill-health and gives blessing, instead of living at home; often it is the fate of the sick to die far from their native land while giving blessing and not to pass away at home."[7]

But why this willingness to make sacrifices? Why the "*voluntarium exilium*", the self-imposed exile ? The best answer to these questions was given by Lajos Áprily (1887—1967) Kossuth prize winner Hungarian poet: "The command of his sacrifice was: hand all you, living in poverty, have acquired in rich countries, over to the poor Hungarians struggling with Turkish and Tartar devastation. And the beautiful sacrifice of a 'Hungarian grown out of his village' commenced in the self-imposed exile . . . He began his difficult work on an untrodden path with the pride of throwing light upon his hardly-known nation in the intellectual contest of more fortunate nations . . . To equalize ! — sounded the war-cry of Hungarian vitality from his restless soul — and the souls of Apáczai, Bessenyei, Kazinczy, Széchenyi answered through the centuries: To equalize !"[8]

A brief summary of his importance can be the following: The historically important fact of the true, conscious discovery of Hungarian language is linked with his name. Up to the time of Leibniz, and even later, it was Szenczi Molnár who proved the right of the Hungarian language to live. He was the Hungarian source of the first researchers of Finno-Ugrian linguistic relation. It was he who with his Latin dictionary and grammar created the preconditions of the scientific study of the Hungarian language, and simultaneously cleared the way to Eopean science for the Hungarian intelligentsia.[9] His linguistic effect could be felt for centuries. His revised Latin dictionary was in use until the middle of the 19th century. His influence on the Hungarian literary language and development of Hungarian poetry was epoch-making.[10]

Besides all this he was an efficient organizer and educator, and one of the most important experts on cultural policy. His life-work can only be evaluated together with the effect it exerted on the young generation of the contemporary Hungarian intelligentsia.[11] According to his biographers he had a sympathetic personality.[12]

This restless Hungarian, this great character of national development and expert on cultural policy in his self-imposed exile made friends with scientists of European fame. Among them perhaps the most important scientist and personality was Johannes Kepler.

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[4] Adattár I. p. 5.

[5] Turóczi-Trostler, J.: Szenczi Molnár Albert Heidelbergben, p. 18.

[6] Dézsi op. cit. pp. 218—219.

[7] "*Saepe solum natale miser felicius extra*
Aegrotat, quam si viveret in patria;
Saepe solum natale mori felicius extra;
Contigit aegrotis, quam periisse domi."
Loci communes, 198.
Szenczi Molnár Albert Naplója, Levelezése . . . p. 112.

[8] Incze, G. op. cit. pp. 10—15.

[9] Turóczi-Trostler: Szenczi Molnár Albert Heidelbergben, p. 152. Magyar Életrajzi Lexikon.

[10] Szathmári, I. op. cit. p. 354.

[11] Adattár I. p. 103.

[12] Toldy, F. op. cit. pp. 102. and 152.

Fig. 2. Portrait of Albert Szenczi Molnár. Painted by Károly Cserna after a print on the front-page of a work published in 1624 in Hanau

It was not by chance that the two scientists met. Albert Szenczi Molnár went to Prague with a copy of his first important work, the Latin-Hungarian and Hungarian-Latin dictionary published in 1604, as he had dedicated it to Emperor Rudolph II, King of Hungary (1567—1612). He arrived at Prague on Tuesday, September 25th, 1604 and was admitted to the scientific and influential circles of Prague on the recommendation of his German friends (Rittershausen, Rumel, Rem, Gentilis Scipio). He could not have complained about welcome and hospitality. At first he probably stayed at the home of Martin Bachatius, university rector, but soon went to live with the Keplers. The biographer notes here that by this Kepler had wanted to repay the hospitality he had met in Hungary when expelled from Graz.[13]

With Kepler's help Szenczi Molnár found entrance into the court, too. Not more than a week after arriving at Prague he showed his work to the Emperor who appreciated it and remitted 50 forints to him. Kepler also introduced him to the astronomers of Maurice, Prince of Hessen. This meeting had a decisive influence on the further course of his life and activity.

He left Prague on November 26th, so he was the guest of Kepler's family for nearly two months. There is no authentic record on the conversations they had during this time. Although in Dézsi's Encyclopaedia of World Literature we can find the following sentence: "among the Hungarians it was Albert Szenczi Molnár whom he" (Kepler) "was on friendly terms and even maintained a correspondence with",[14] according to Turóczi-Trostler's study published in

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[13] Kepler op. omnia VIII. 701. Günther: Kepler, Galilei Berlin 1896. 10. Természettudományi Közlöny 1872. 85. Czógler: A fizika története (History of physics) 1882. I. 146. Cited by Dézsi op. cit. pp. 126—128.

[14] II.

1955[15] and also on the basis of the author's own research Kepler's letter dated on 13th February 1605 should be considered as the only authentic source concerning their friendship. Nevertheless, this letter is enough to show what sort of friendship existed between the two great scientists.

Kepler's letter

"S. P. D. Accepi literas tuas, Molinari suavissime easque geminas; alteras cum exemplari Ungarici lexici, quod mihi est gratum ob auctorem, etsi optarim, te id in meliorem tuum usum convertisse. Sed dummodo ad tuos usus tibi alia suppetant, pergratum habebo. Gratias tibi ago de procurato meo negotio: id sic recte habet. Cum Suendero enim videbatur mihi nimia properatio et poenitudine ductus retinui literas; de hoc vero Odontio in magnas spes erectus sum negotit cum utriusque emolumento et academiae vestrae honori conficiendi. Legas ipse, quae ad ipsum scripsi. Exemplaria tua cetera sunt curata, puto te responsum accepisse. Salutes inter notos tuo voto divisi, quae gratae fuerunt eandemque tibi renunciare iussus sum.

OMNIA vestra Wackerius vultu cognomine suscepit, rectiore nempe, quam duada, sed tamen et digna iudicavit, in quae insurreget contrariis versibus et suggilationibus poeticis.

Haydones hic meuto ut meo dicterio rectissime habituri fuerint, si primo quoque tempore essent oppressi. Nam Caesar in ipsos se parat et dissentiunt invicem. Et Boczkayum cum pecunia deseruit autoritas, ut ferunt et capitaneos suos ipse interficit. Etiam de Walachiae wayvoda Radullo narrabatur, quod arcem ipsius occuparit 4 miliaribus a Waradino Petzumque liberarit. Deus piorum rationem habeat in his turbis. Vale et me ama atque bonis viris commenda. 13. Februarii 1605. Tui amicus officiosus J. Keplerus.

P. S. Cum doctore Hoer locutus ipse. Cupit se conveniri et ab Odontio et ab eius commendatore, liberalissime est pollicitus, puto iam esse in itinere domum versus. Ergo, quod estis facturi, statim aggredimini, ne domi illum non inveniatis. Etiam Tengaglius cupit sibi adesse aliquem in arte nostra excellentem, pollicetur salarium honestissimum, splendidius fortasse, quam professoris alicuius."

Outside address; "Doctrina et pietate praestanti viro, domino Alberto Molnar Ungaro, literarum studiis in academia Altorfiana operanti, domino et amico meo colendo."[16]

("I wish you good health. I have received your letter, dear Molnár, in fact, I have received all of them, also the one you have sent me with the copy of the Hungarian Dictionary. With regard to its author I highly appreciate it, though in someone else's hand it might be of more use. I am very glad you have been given assistance in your work by others too. Thank you for seeing to my business, it is settled now. Seeing the great hurry in Suender I gave up — though not willingly — writing, nevertheless I expect much from Odontius in the cause that would mean advance for both of us and the praise of your academy. Read it yourself what I have written to him. I have made arrangements concerning your other copies too; I think you have already received the answer. I furthered your greetings to your acquaintances; they were pleased and asked me to greet you in their names.

Wacker accepted your work OMNIA with mixed feelings, but found it good enough to answer with counter-poems and poetical irony.

I am afraid the Heyducks will be judged the way I have told you if beaten at the very beginning. Namely, the Emperor is going to attack them, and there is also a lack of unity among them. In addition, Bocskay has run out of both money and prestige and — they say — had his captains killed himself. Radul, Wallachian voivode is said to have occupied his fortress

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[15] Szenczi Molnár Albert Heidelbergben.

[16] The original in "Öffentliche Bibliothek der Universität Basel". Mscr. G^2. I. 15^1, BI: 127. — In Print Szenczi Molnár Albert Naplója (Diary of A. Sz. M.) pp. 177—178. As far as we know it is the first time this letter is published in English.

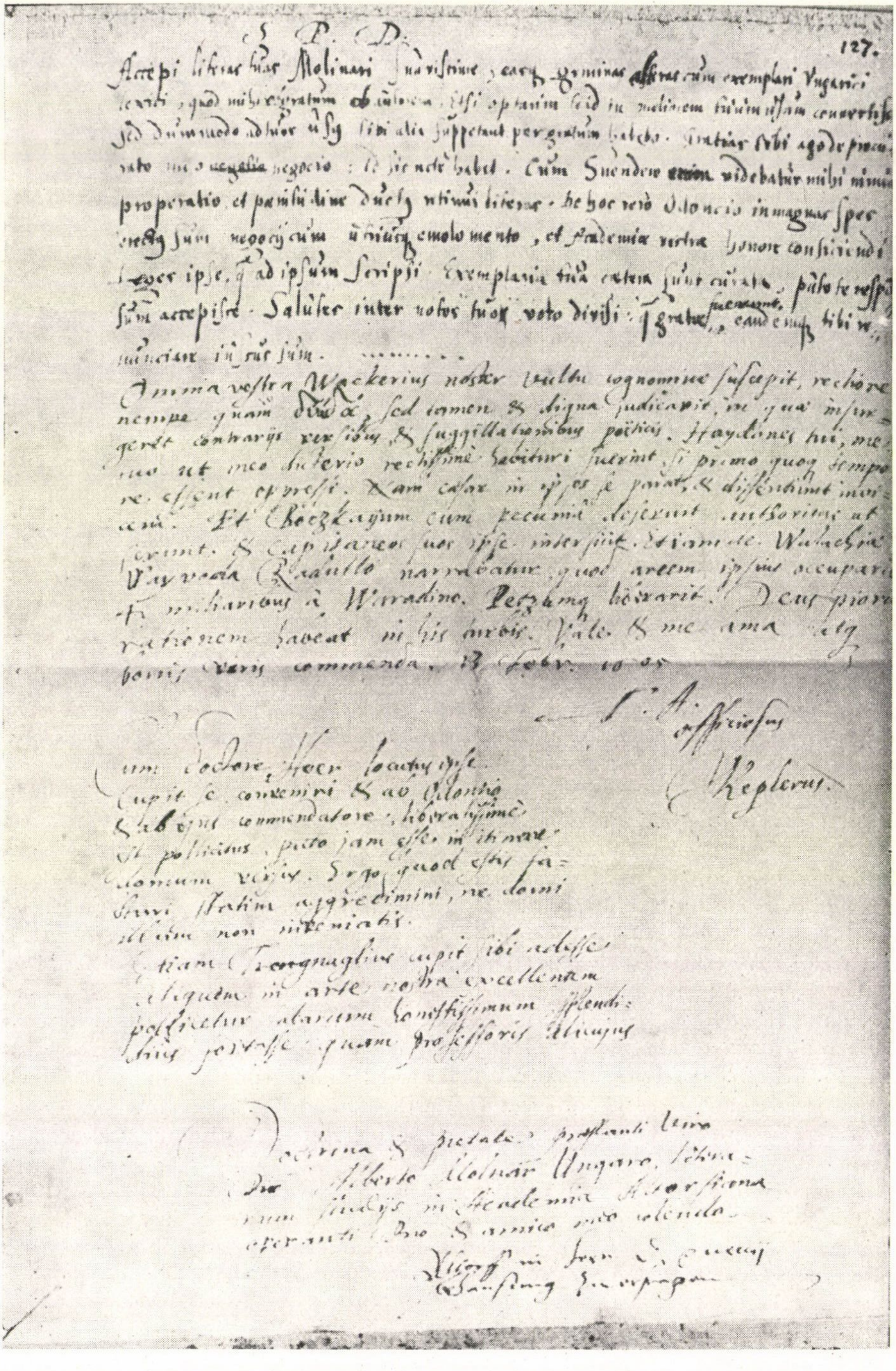

Fig. 3. Kepler's letter to Szenczi Molnár. The original is in the Öffentliche Bibliothek der Universität Basel

4 miles from Várad and liberated Petzum. God cares for the faithful in times of trouble. Good by, love me and recommend me to decent people. 13 February 1605. Your faithful friend Johannes Kepler.

P. S. I spoke to doctor Hoer myself. He wished and promised to meet Odontius and also the person who recommended him; in fact, I think he is on his way back home. Therefore set about quickly whatever you want to do lest you will not find him at home. Tenanglius wants a person talented in our profession, too, to whom he will offer a good salary, perhaps better than what is due to a professor."

Outside address: "To Mr. Albert Molnár, the excellent and pious scientist, who works hard for scientific progress at the Academy of Altdorf, to my honourable friend."

Let us make a few remarks on the letter, first what József Turóczi-Trostler generally says about the letters addressed to Albert Szenczi Molnár: We are familiar with the common phrases of baroque politeness and correspondance which do not impose any obligations on the writer; but when we read the letters written to A. Szenczi Molnár we at once notice the love and respect expressed in them, the genuineness of which we have no reason to disbelieve in, all the less since they are not addressed to any person of high rank or dignity, but to a poor travelling student or corrector or family tutor.[17]

Love and respect can be felt from Kepler's above letter too. The two months spent together certainly left their marks in the souls of both scientists. The letter shows that they got close to each other which was only natural as their ideas and destinies were similar. Both were working for scientific progress far from their countries, so it can be easily understood that a true friendship was formed between them. This friendship was not confined to vague feelings and mere politeness, it was — like every true friendship — a definite, concrete relation in which the parties cared for and helped one another and worked for the common cause to which they had dedicated their lives.

The effect of Kepler's friendship:

There is no way to show the effect this friendship exerted on Kepler, but its influence on Albert Szenczi Molnár and through him on Hungarian culture can be summarized in the following: 1) This friendship — like the other similar friendships formed with famous scientists — supported his life in periods of need and sorrow.[18] 2) The success of his journey to Prague and Kepler's hospitality became known and he rose in his protectors' esteem who made efforts to find him a post.[19] 3) Through Kepler he met in Prague the court astronomers of Maurice, Prince of Hessen.

— Maurice, Prince of Hessen was one of the greatest rulers of that time (1572—1632). He was 21 years old when ascended the throne. He possessed excellent qualities to reign and received a many-sided scientific education. He not only supported but also cultivated science and art. In addition to the classical languages he mastered 5 languages including Hungarian. The golden age of Hessen fell in the period of his reigning.[20] —

On the advice of the astronomers Albert Szenczi Molnár dedicated his new great work „*Psalterium Ungaricum*" to Prince Maurice. The Prince welcomed the dedication and took Szenczi Molnár in his protection. It was then that the great period of his life began. a) The Prince gave him a present and handed him a letter addressed to the rector of the Marburg University with the order of admitting Szenczi Molnár to the university and giving him full board there. b) Then he fulfilled his old favourite plan: the revised edition of Gáspár Károlyi's

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[17] Albert Szenczi Molnár in Heidelberg, p. 18.

[18] Szenczi Molnár Albert kifejezései (Phrases by A. Szenczi Molnár). See: Toldy op. cit. pp. 163 and 165. Statement by Lajos Áprily, op. cit. p. 6.

[19] Dézsi, op. cit. p. 130.

[20] Rehm: Geschichte d. beiden Hessen. 1846. II. 99. Cited in Szenczi Molnár Albert Naplója (Diary of A. Sz. M.) pp. 46—47. and Dézsi, op. cit. p. 140.

Bible. c) He wrote a Hungarian grammar book commissioned by Prince Maurice. This was the first Hungarian grammar book which — together with a syntax — has survived for us in full and was used as a manual up to the end of the 18th century. d) As a result of the Prince's patronage he rose in his Hungarian and foreign friends' esteem.[21] All this began in Prague and were due to Kepler's friendship.

Acknowledgement

This paper is published as another result of international friendship. We are indebted to Mr. Max Burckhardt dr., librarian of the "Öffentliche Bibliothek der Universität Basel" for willingly sending us a photocopy of Kepler's original letter; further, to Ladislas Csémy, university professor at Prague, for supervising the Kepler works listed in the references.

P. Hargita

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THE ANION DEPENDENT EFFECT OF AMMONIUM ON RIBONUCLEIC ACID SYNTHESIS IN PINTO BEAN LEAVES

The influence of chloride (Haas 1944) was compared with other anions too, with identical cation, by characterizing the intensity of ribonucleic acid synthesis. Possible chloride inhibition in bean leaves of high protein content can supposedly be well demonstrated through the ribonucleic acid synthesis.

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[21] Dézsi, op. cit. pp. 143—155

Disks excised from the primary leaves of Pinto bean were floated for 18 hours on a 10^{-3} mol solution of pro anal. ammonium nitrate, ammonium sulphate and ammonium chloride. The latter was also compared with technical ammonium chloride as to its effect.

After the pre-treatment with the ammonium salts the incorporation of uracil-2-^{14}C into the ribonucleic acid fraction insoluble in 10% trichloro-acetic acid was determined in a three hour exposition after FLETCHER—OSBORNE (1965). Beside the incorporation values the standard error of the mean value ($E = \frac{\sum(x - \bar{x})}{n}$ was also expressed (SVÁB 1961). Technical ammonium chloride was put to our disposal for experimental purposes by the Borsod Chemical Works (Kazincbarcika).

According to the data of Table 1 all three pro anal. ammonium salts stimulated the ribonucleic acid synthesis as compared to the distilled water control. With sulphate and chloride applied, however, the degree of stimulation was very low compared to the effect of nitrate. Technical ammonium had no influence on the ribonucleic acid synthesis. This observation is all the more important since — according to the results of investigations in other subjects — technical ammonium chloride inhibits the photosynthetic carbon dioxide fixation (HORVÁTH—POZSÁR 1970).

Table 1

Anion dependent effect of ammonium ion on the incorporation of uracil-2-^{14}C into insoluble ribonucleic acid in Pinto bean leaves, in a 3 hours exposition, as related to 0.34 mg protein, after floating for 18 hours on 10^{-3} mol solutions in comparison with distilled water

Water content of leaves: 67%

Treatment	Incorporation cpm/250 mg fresh weight	Standard error of mean value	Specific activity	
			cpm/mg	%
H_2O	32 920	2573	96 823	100
NH_4NO_3 pro anal.	43 485	3112	127 897	132
$(NH_4)_2SO_4$ pro anal.	36 704	2792	107 952	111
NH_4Cl pro anal.	34 386	2117	101 136	104
NH_4Cl techn.	32 671	2408	96 091	99

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Prepared by the Institute of Isotopes of the Hungarian Academy of Sciences, Budapest; Agrobotanical Institute, Tápiószele.

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THE MODIFYING EFFECT OF FULL-FLOWERED CHARACTER ON THE FORM OF HYPANTHIUM AND POSITION OF GYNOECIUM IN SOME ROSA VARIETIES

I. MORPHOLOGICAL CONDITIONS

The hypanthium of *Rosae*, in the cavity of which the pistils develop, is formed according to some authors from parts of floral leaves (calyx, petals, stamina) joined at the base (DE CANDOLLE 1813, BOUTINEAU 1882, VELANOVSKY 1904), according to others through the deepening of the torus (JUSSIEU 1843, MASTERS 1869); while according to a third opinion the lower part of the hypanthium is of axial origin and the upper part develops from the basal zone of floral leaves grown together (VAN TIEGHEM 1878, JACKSON 1934, EAMES—MAC DANIELS 1947, TAHTADYAN 1948, RAUH—REZNIK 1951, EAMES 1961).

This shows that the question has not been answered so far. In the course of studies, performed in connection with the problem of inferior pistil, several wild, and many cultivated Rosa varieties were dealt with, and a great variedness of the form of the hypanthium was observed. This raised the suggestion of examining in detail the possible causes of the different forms of hypanthium in the Rosa species and varieties.

Apart from *Rosa canina* some 300 *Rosa* varieties were examined with a quick method in the rose collection of the Horticultural Research Institute, out of which the flower- and hypanthium formations of *Rosa canina*, *Rosa rugosa*, Chicago peace, Rosa Gayard, Rosa sp, Memoriam and Wasser Centennial are discussed in detail. In the varieties examined trends in the number of floral leaves were statistically evaluated and certain special conditions photographed.

The 1—2 cm long peduncle of *Rosa canina* is followed by an egg-shaped hypanthium (Fig. 1/A). On the top of the hypanthium there is a round opening; its wall is considerably thickened, so a wide flattened rim develops around the opening. On this rim — as it is known — 5 spirally arranged sepals, then — along a circle — 5 petals grow in inward direction, and on subsequent nodes 80—90 stamina. The styles (25—28) overhang the opening of the hypanthium, the ovary is located in its cavity. Styles of pistils sitting on the side walls hang inward to the opening of the hypanthium. *Rosa rugosa* shows a similar flower structure with the difference that its hypanthium is spherical and slightly flattened at the top (Fig. 1/B).

The hypanthia of the cultivated rose varieties examined differ from these two basic forms in various degrees. There are varieties where hypanthia are more open at the top, that is, the side walls do not close again above their cup-like widening, and thus a narrowing cannot be found below the base of the floral leaves — as in *Rosa canina* and *Rosa rugosa*.

Hypanthia of the large flowered varieties Chicago peace and Rosa Gayard (Fig. 1/C, D) widen above the peduncle and — the side-walls being short — show a semi-spherical form open at the top. Not only does the upper rim of the hypanthium become broad, but the side-walls also thicken considerably. Pistils are found on the inner side of this flattened hypanthium. The styles grow straight upward without bending.

In the variety Memoriam (Fig. 1/F) and a cultivated variety of unknown origin called Rosa sp. (Fig. 1/E) a characteristic structure of torus can be seen. The peduncle below the hypanthium widens in a V-formation and produces a triangular hypanthium with the tip upside down, widest at the upper part where the floral leaves develop. The pistils bend inward, so the styles grow upward after forming a slight curve. The cavity of the wedge-shaped hypanthium is the deepest in the rose variety of unknown origin, in the variety Memoriam it is smaller and less deep and thus has the form of a wide, flat wedge.

In the variety Wasser Centennial the torus becomes so wide and flat that it shows the form of a plate (Fig. 1/G), where the straight upright pistils can be found floral leaves grown out at the edge, make a curve and cover the wide, typically superior apocarpic gynoecium.

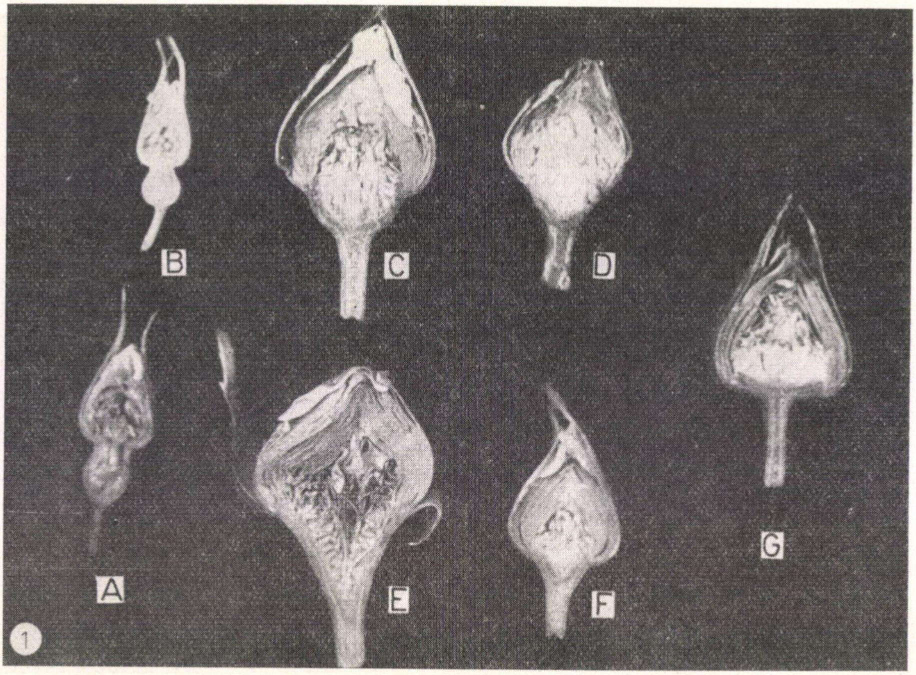

Fig. 1. Degrees of modification in the hypanthia of rose varieties. In the upper row hypanthia show a concave, while in the lower one a V-formation. A) Rosa canina; B) Rosa rugosa; C) Chicago peace; D) Rosa Gayard; E) Unknown rose variety; F) Memoriam; G) Wasser Centennial

Table 1

Trend of the number of floral leaves in certain rose varieties in comparison with Rosa canina
(on the basis of 10 replications each)

Species and varieties	Number of floral leaves			
	sepals	petals	stamina	pistils
Rosa canina	5	5	90	28
Chicago peace	5	60	182	178
Rosa Gayard	5	42	299	187
Rosa sp.	5	48	210	310
Memoriam	5	31	228	86
Rosa Centennial	5	30	102	154

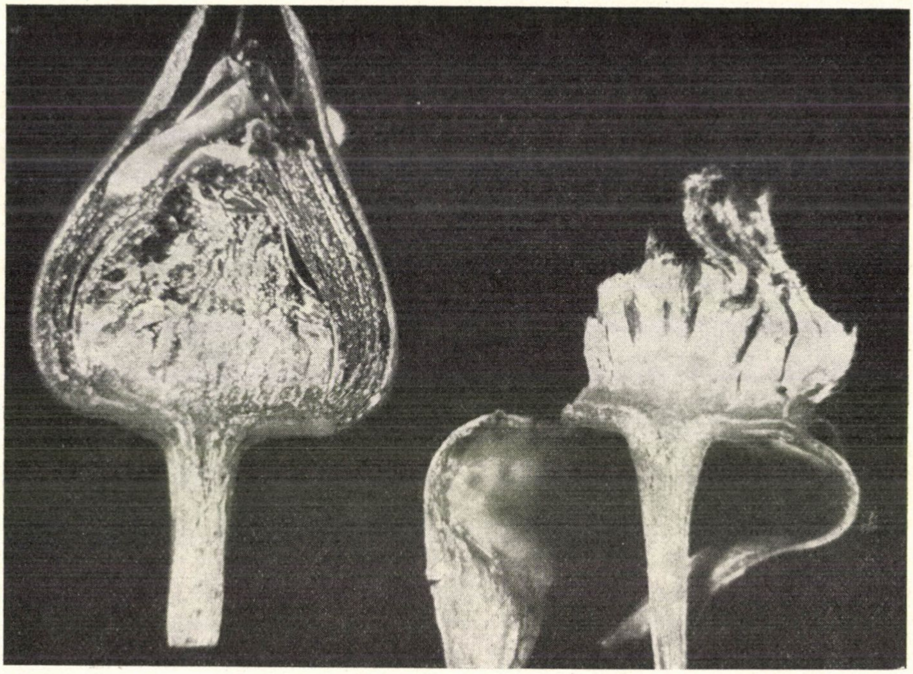

Fig. 2. Longitudinal section of the flower of Rosa Centennial with a flattened hypanthium

The author examined the trend of a number of floral leaves (sepals, petals, stamina, pistils) in the above rose varieties (Table 1).

As the table shows, the number of sepals is constant (5), while that of the petals changes with the variety (30, 42, 48, 60). The increase in the number of petals resulted from the outer stamina having also become petals. In spite of this, the number of stamina also shows a considerable increase (102, 190, 210, 299). Increase in the number of pistils is even more expressed; in certain varieties 86, 154 and 310 pistils were found.

The increased number of petals, stamina and pistils resulted in a reduction of the volume of hypanthium, and its transformation and modification respectively. Simultaneously with the decrease of its volume the hypanthium becomes wider and more or less flat, with considerably thickened walls. Petals and stamina develop not only at the edge but also on the inner surface of the hypanthium, which results in its further flattening. Through the flattening of the hypanthium the base of the pistils rises, and in the case of the variety Wasser Centennial it can be found at the same level as the other floral leaves. So, by the raising of the gynoecium the pistils change from inferior to superior position.

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CONTRIBUTION TO THE METHODOLOGY OF STUDYING CHROMOSOMES IN THE ROOT TIP CELLS OF SOLANUM LYCOPERSICUM L.

When making dissections for karyological studies it is very important to determine the suitable reagent, the maceration time, the adequate staining method and the time of differentiation. After comparing the methods known so far for studying chromosomes, in the case of *Solanum lycopersicum* we considered the following method as the most suitable.

Seeds germinated for three days at 25 °C and developed 1—1.5 cm long roots. The root tips were placed into a 8-hydroxy-chinoline solution for 3 hours at room temperature for prefixation, then placed for 20 minutes — according to Carnoy's method — into a fixing solution consisting of 2/6 absolute alcohol, 3/6 chloroform and 1/6 concentrated acetic acid. Then the material was macerated for 8 minutes in a mixture of 36 per cent alcohol and concentrated hydrochloric acid, and finally washed for 20 minutes in tap water.

As a further step, the dissection was crushed under cellophane foil in the following way: root tips were placed onto a slide and covered with a piece of cellophane foil of about the size of a cover glass. Root tips were crushed with a rubber cork and smashed to a thin layer by rolling a test-tube back and forward. Superfluous moisture was removed by means of a filter paper. Then the slide was placed into a cuvette with some formaldehyde solution at the bottom (cca. 2 cm). Under the influence of the formaldehyde fumes the dissection adhered to the slide. 45 minutes later the cellophane foil was removed with the aid of forceps, and the dissection was washed again in tap water for 20 minutes. After having perfectly been washed out it was stained with Cajal—Brozek's method. First, 1 per cent solution of fuchsine was applied for 3 minutes, then the dissection — after having been rinsed — was submerged for 5 minutes in a mixture (of 2 : 1 ratio) of concentrated indigocarmine solution and picric acid. Following an alcoholic rinsing the dissection was treated with increasing concentrations of alcoholic solutions which resulted in adequate differentiation and dehydration. The alcohol treatment was completed by using absolute alcohol. Finally, the dissection was submerged in xylene twice for over 5 minutes each time, then placed into Canada balsam.

With the method described above we succeeded in preparing dissections in which the chromosomes could be thoroughly studied.

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F. OAT

Taxonomical place: *Avena sativa* L. ssp. *patula* (Alef). **Werner** var. *mutica* Alef.

Origin: produced from a Hungarian commercial variety of Kompolt by individual selection.

Beginning of breeding: 1918, Kompolt (County Heves).

Breeder: † Rudolf Fleischmann and József Schmidt, Kompolt; variety maintainer: Sándor Mórász and Sándor Héjja, Kompolt.

State qualification: State registered improved variety, 1951; first certification 1934, first registration 1940.

General characterization: fairly high yielding, drought tolerant, white paniculate oat of extensive character and moderately rapid development.

Morphological description:

Root system: side roots penetrate deep — about 160—180 cm — into the soil.

Shoot system: of excellent stooling but medium development; extent of stooling: 2.7 side shoots.

Culm: grows to an average height of 130 cm; number of internodes 6/7, nodes are barrel-shaped, 4—6 mm long. Culm is dark straw-coloured; under rainy conditions is sometimes lodged due to its fine structure (MÁNDY 1941, HORVÁTH 1952).

Foliage: 5—6 medium green leaves with 1—1.5 cm broad lineal-lanceolate blades may grow on the shoots; ligula is of 4×8 mm size and triangular. Number of leaf veins: 33.

Panicle: wide, stiff, about 25 cm long, with arched diverging branches. The main axis of the panicle is generally divided into 7 internodes which are so long as to make the structure of the panicle loose. The involucel is found at the lowest node; it is narrow at both sides and shows a V-shaped incision at the back. The involucel surrounds the main axis at right angles and holds together the basal part of 6—11 branches of panicle. Average number of spicelets in panicles 43.8 (ranging from 26 to 56), number of grains 68.9 (ranging from 39—87), weight of grains 1.62 g (ranging from 0.7 to 2.3); awned grains are found only in 0.13 per cent (HORVÁTH 1952). Average number of awned grains in spicelets: 2; awns adhere closely to grains. There is a tunicate point at the tip of the glume.

Hulled caryopsis: spindle-like; characteristically long-haired at the basal part. Colour yellowish white (in quartz light white). Length of hulled grains: 1.0—1.5 cm. Hl-weight 38.1 (ranging from 31 to 44) kg; thousand-grain-weight: 23.3 g (ranging from 21 to 24 g). Hull percentage: 30.1 (ranging from 27 to 38%). Protein content of hulled grain: 12.3%.

Biological characteristics:

Germination: cardinal points minimum +4 °C, optimum 25 °C, maximum 37 °C; salt solutions of low concentration (0.1%) slightly stimulate germination (NaCl), higher concentrations, however, decrease its percentage; in a NaCl solution of 3% 17% germinate (MÁNDY—PÁL 1960).

Vegetation period: number of days between sowing (1st April) and panicle formation: 85; from panicle formation to full maturity 33 days are required; vegetation period is of 118 days (medium late variety).

Development: excellent stooling, moderate development.

Resistance to diseases: fairly resistant to rust *(Puccinia)* and smut *(Ustilago)*.

Farm technology requirements: optimum sowing time in Hungary between March 25th and April 10th, required amount of seed grain 2.8—3.0 million grains per cad.yoke (1 cad.yoke = 1.422 acres = 5754.56 m²). Under intensive conditions and well-preserved soils gives high and reliable yields, but also tolerates less favourable conditions (KAPÁS *et al.* 1965).

Productivity: a good yield, 13—14q/cad.yoke (ranging from 7 to 15 q), straw yield 34 q/cad.yoke. Loss from grains dropping is unimportant.

Area of cultivation: the whole area of Hungary, but especially the Great Plain and the North-Eastern Hill-Country.

*

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FORUM

THE DETERMINATION OF THE EFFECT OF SOLUBLE PROTEIN LEVEL ON THE INTENSITY OF PHOTOSYNTHETIC CARBON DIOXIDE FIXATION

The specific activity as referred to the chlorophyll is generally used in relation to the intensity of photosynthetic carbon dioxide fixation (DALY—LIVNE 1966, LIVNE 1964, POZSÁR 1967). Data of cpm/mg chlorophyll suggest a varying photochemical activity to be displayed by the chlorophyll especially when its level in the leaf tissues is very low, e.g. as a result of a virus infection (POZSÁR—HORVÁTH—LEHOCZKY—SÁROSPATAKI 1969), or when — due to a hormon-like effect which stimulates the protein synthesis — biological activity in the leaf tissues increases (OSBORNE 1962, KULAEVA—BOROBEVA 1962, JORDANOV 1966, POZSÁR 1967). In the latter cases the chlorophyll level may increase too, according to the experimental data of KURSANOV *et al.* (1964) and STETLER—LAETSCH (1965).

The author's data on photosynthetic carbon dioxide fixation, obtained under the condition of virus infection showed that in an advanced stage of infection — when the chlorophyll level decreased — the specific activity in relation to mg chlorophyll considerably increased. According to the data in the virus affected tissues, the photochemical activity of the chlorophyll increased. This fact suggests that the assumed relationship with the chlorophyll may be incorrect. It is especially questionable in the cases of extremely low or high chlorophyll levels.

In earlier experiments performed with synthetic cytokinins (POZSÁR 1967) the intensity of carbon dioxide fixation in relation to chlorophyll was also found to be unreasonably high. On the basis of experimental data obtained it could be concluded that under the influence of kinetin and benzyladenine treatments the photochemical activity of chlorophyll increased but this indirect conclusion has not been confirmed by later experiments in other relations.

The above data on photosynthetic carbon dioxide fixation, related to the two extreme chlorophyll levels, have challenged the validity of relating to chlorophyll; it is, however, a general practice in literature. One possible idea is that the different protein fractions play a significant part in the processes of photosynthetic carbon dioxide fixation, at the photochemical activity of chlorophyll. However, the regenerative, reductive and carboxylation processes of the Calvin-cycle are enzymological mechanisms in the dark, so they are biochemical reactions connected with protein localized by structural elements. It can well be supposed, even without direct data on molecular localization, that the intensity values of photosynthetic carbon dioxide fixation, related to protein content and soluble protein level respectively, approach the biological activity much better than the chlorophyll related specific activity used so far, in spite of the fact that chlorophyll is in a functional relationship with protein elements in the ultrastructure of the chloroplast. This theory has been confirmed in other correlations by data obtained in the electronmicroscopic study of the chloroplast. By disclosing the orientated structure of quantosomes PARK (1963) and BASSHAM (1966) pointed out that these form a monomolecular layer transversally covering the (monomolecularly dissolved) double layered thylakoid membranes associated with the chlorophyll layers.

On the basis of the above, utilizing differences of solubility, several protein fractions were separated and — besides their relationship to the chlorophyll level — the photosynthetic carbon dioxide fixation data were related to total protein and to soluble protein content too, in order to prove the correlations experimentally.

The intensity of photosynthetic carbon dioxide fixation was determined by incorporating ^{14}C-labelled carbon dioxide released from barium carbonate by means of lactic acid, after ARNON's (1961) method. The specific activity of ^{14}C-labelled barium carbonate was 130 mi.ci./g of which 120 mi.ci. was used in a 5 litre exsiccator. The radioactivity of leaf tissue homogenates was determined by the liquid scintillation method in Packard's tricarb apparatus.

Following the ethyl alcohol extraction the chlorophyll content of the leaves was determined with Unicam spectrophotometer at a wave length of 665 nμ and the extinction values obtained related to mg chlorophyll.

Leaf protein fractions were released with 0.5% NaCl, then with 4 N NH_4OH and followed by 20% NaOH, and the nitrogen content of fractions obtained, as well as of the initial, was determined with the micro-Kjeldahl method and expressed in mg fresh weight.

Photosynthetic carbon dioxide fixation was given by the difference of carbon dioxide fixation data obtained in light and in the dark, and the latter values were related to mg chlorophyll content, to mg total protein, and to soluble protein level (in 0.5% NaCl), respectively. The latter is usually called the specific activity of photosynthetic carbon dioxide fixation. Specific activity data were related finally to the relative percentage of the controls, for the better comparison of these data.

Details of the experimental methods and conditions of sample taking were published in earlier papers (POZSÁR 1967, BÓCSA—POZSÁR—MAJKÓ 1969, DANCS—CSORBA—POZSÁR—FERENCZ 1969).

From the results of earlier experiments the conclusion was drawn, that apple leaves react to infection by Venturia inaequalis with a considerably decreased intensity of photosynthetic carbon dioxide fixation (DANCS—POZSÁR—FERENCZ 1968, DANCS—CSORBA—POZSÁR—FERENCZ 1969). According to the data obtained, in the affected leaves the chlorophyll content decreased by 38%, and the specific activity related to the chlorophyll to 23%, as shown in Table 1. The experimental data suggested that the infection reduced the photochemical activity of chlorophyll.

On the other hand, in an advanced stage of the infection the chlorophyll content in virus-affected vine leaves decreased considerably too — to 6% of the original level —, while

Table 1

Effect of infection with Venturia inaequalis on the fixation of carbon dioxide in light, in the dark and the photosynthetic carbon dioxide fixation with the aid of labelled compounds in apple leaves, expressed in cpm/100 mg fresh weight (DANCS—CSORBA—POZSÁR—FERENCZ 1969)

Tissues	Carbon dioxide fixation			Chlorophyll content mg/100 mg fresh weight	Specific activity cpm/mg chlorophyll
	in light	in the dark	photosynthetic		
Healthy	26 300	6 900	19 400	2.4	8 082
Infected	11 300	1 900	9 400	1.5	6 266
Percentage inhibition caused by infection	—	—	—	38	23

the chlorophyll-related specific activity of photosynthetic carbon dioxide fixation showed but a slight decrease, having been reduced to 72% of the original value. When looking at the data of Table 2 it is very significant that on the basis of specific activity related to the chlorophyll content at the initial stage of infection the photosynthetic carbon dioxide fixation decreased to 46% as compared to the healthy leaf tissues, while in a later phase of the infection, when with the very low chlorophyll content, and the specific activity related to the chlorophyll relatively increased, that is, it was reduced only to 72% of the original control value. As the infection progresses, the relative increase in value results in a conspicuous difference in the ratios. Experimental data referred to, were explained in earlier publications (Pozsár—Horváth—Lehoczky—Sárospataki 1969, Bócsa—Pozsár—Majkó 1969, Dancs—Csorba—Pozsár—Ferencz 1969) by an increased photochemical activity of the chlorophyll. In subsequent experiments this theory became questionable.

Table 2

Carbon dioxide fixation in healthy and GCM virus diseased vine leaves, as compared to the photosynthetic carbon dioxide fixation (Pozsár—Horváth—Lehoczky—Sárospataki 1969)

Red Veltliner vine variety GCM symptoms	Carbon dioxide fixation in cpm			Chlorophyll content mg/100 mg fresh weight	Specific activity of CO_2 fixation	
	in light	in the dark	photo-synthetic		cpm/100 mg chlorophyll	%
Healthy	21 084	147	20 937	0.350	60 240	100
Slight	4 682	52	4 630	0.167	28 035	46
Severe	916	31	885	0.021	43 619	72

Under the influence of synthetic cytokinins (kinetin, benzyladenine) — in contrast to the pathophysiological processes discussed above — the chlorophyll content in the leaf tissues increased very slightly, while the intensity of photosynthetic carbon dioxide fixation related to the chlorophyll level increased to an extremely high degree as shown in Table 3. The latter result cannot be satisfactorily explained by the increased photochemical activity of chlorophyll either, although in an earlier publication (Pozsár 1967) a correlation was thought to have been found between hormonal effects and changes in the physico-chemical character of the chlorophyll.

Table 3

Effect of synthetic cytokinins on the intensity of photosynthetic carbon dioxide fixation in Pinto bean leaves (Pozsár 1967)

Cytokinins	ppm	Carbon dioxide fixation in cpm			Chlorophyll content mg/100 mg fresh weight	Specific activity of CO_2 fixation	
		in light	in the dark	photo-synthetic		cpm/mg chloro-phyll	%
Control	—	9 110	670	8 440	0.87	9 701	100
Kinetin	50	12 570	905	11 665	0.97	12 025	138
Benzyladenine	30	19 480	810	18 670	1.05	18 550	221

The intensity of protein synthesis in the leaf tissues can be well characterized by the incorporation the ^{14}C-labelled amino acids (glycine-1-^{14}C) into the leaf proteins, with the method of floating in short time (3 hour) expositions as described in earlier papers (Dancs — Pozsár — Ferencz 1968, Dancs — Csorba — Pozsár — Ferenc 1969). By the partial fractioning of leaf proteins we have succeeded in proving directly that the highest radioactivity per unit time accumulates in the soluble protein fraction, as shown by Table 4. In protein fractions the radioactive carbon labelled amino acid accumulated at very different rates. The radioactivity of the insoluble structural protein fraction could be demonstrated only much later and was much lower than in the soluble fraction. On the basis of data obtained, the biosynthetic intensity of soluble proteins can be considered linear, as is clearly seen in Table 5. These data directly prove that the synthesis of the soluble proteins is primary in the leaf tissues, and also that their metabolism is supposedly much more intensive, so they play a significant part in many metabolic processes both directly and indirectly. This is probably especially true in the quantosome level, which has exceptional importance in the photosynthetic carbon dioxide fixation rocesses, above all in the Calvin-cycle.

Table 4

Incorporation of radio carbon labelled amino acid (glycine-1-^{14}C) into the different protein fractions of the leaves of Bezostaya-1 wheat variety, in 1000 cpm/100 mg fresh weight

Medium for solubilization	Incorporation in hours		
	3	6	18
0.5% NaCl	12.5	20.1	43.7
4 N NH_4OH	—	3.1	22.0
20% NaOH	—	—	10.6

Table 5

Incorporation of radio carbon labelled amino acid (glycine-1-^{14}C) into the soluble protein fractions in the leaves of Bezostaya-1 wheat variety

Exposition in hours	1000 cpm/100 mg fresh weight
1	12
2	20
3	27
4	33
5	38

Owing to the intensity of synthesis of soluble protein fraction it is highly probable that specific activity, when related to the total proteins and to soluble protein level, and in the later cases the correlation with the photosynthetic carbon dioxide fixation, is much better than when related to the chlorophyll content, especially in cases of extremely low and high chlorophyll contents. Table 6 compares the photosynthetic carbon dioxide fixation data of

Table 6

Photosynthetic carbon dioxide fixation by different plant leaves as related to chlorophyll, to total protein and to soluble protein content, as a percentage of healthy or untreated ones

Test materials	Related mg fresh weight	Chlorophyll mg	Total protein mg	Soluble protein		Photosynthetic CO_2 fixation related to		
				in mg	% in total protein	chlorophyll mg	total protein mg	soluble protein mg
Apple leaves	100							
Healthy		2.4	4.1	2.1	53	100	100	100
Infected by *Venturia inaequalis*		1.5	3.8	0.8	22	77	64	42
Vine leaves	100							
Healthy		0.350	2.6	1.1	45	100	100	100
GCM symptoms slight		0.167	2.2	0.2	11	46	36	26
severe		0.021	1.9	0.05	3	72	15	7
Bean leaves	250							
Untreated		0.87	13.4	7.6	57	100	100	100
Cytokinin treated ppm								
Kinetin (50)		0.97	17.0	10.3	61	124	108	98
Benzyladenine (30)		1.05	22.3	16.7	75	191	133	105

different test materials as related to the chlorophyll content, to total proteins and to soluble protein level, respectively. The new evaluation of specific activity indicates the correlation existing primarily between the photosynthetic carbon dioxide fixation and the soluble protein level. The comparative data directly show that in the pathological processes the decomposition of chlorophyll is accompanied by a protein decomposition and — to an even higher extent — by a decrease of soluble protein level, and that the latter shows a positive correlation with the intensity of photosynthetic carbon dioxide fixation.

According to the results of experiments carried out with the new type of synthetic plant hormones, the level of soluble protein fractions increased primarily in the leaves, and the intensity of photosynthetic carbon dioxide fixation is related to the level of soluble proteins instead of being related to the chlorophyll content, then the intensity of the process becomes equalized, because of the positive correlation. When the cytokinin treatment was applied, the correlation between soluble proteins and photosynthetic carbon dioxide fixation was nearly the same — though with higher values — as originally, being 98% for kinetin treatment, and 105% for benzyladenine.

With a close relation to data on protein fractioning and by a specially new interpretation of our experimental data we have succeeded in pointing out directly that under the influence of cytokinin treatments, the level of the soluble proteins increases primarily, and the intensity of the photosynthetic carbon dioxide fixation is positively correlated. Owing to the positive correlation it is highly probable that the increased intensity of photosynthetic carbon dioxide fixation in the treated leaves can be attributed to the increased level of soluble protein fractions.

The effect exerted by the cytokinins on the development of the chloroplast and the regulation of its ultrastructure is especially significant in the ability of growing leaves to prevent the decomposition of chlorophyll. It also exerts an influence on the manifestation of biological effectiveness in the mature leaves, supposedly owing to a stimulating effect on the protein synthesis, that is, through a relative increase in the level of soluble protein fractions.

There is no doubt that a functional interrelation exists between the chlorophyll and the soluble protein fraction, but it is highly probable too, that this correlation does not appear either in a chemical association or in complex formation. The absence of either is indicated by many correlation data, first of all by the fact that the chlorophyll is of lypophyl character, while the protein — and especially the biologically active soluble protein — is of hydrophyl nature. Spatial limitation can be demonstrated in the ultrastructure of the chloroplast too, inasmuch as chlorophyll is localized always in the double thylakoid layers, in an orientated structure, while the soluble proteins are arranged in crystal-lattice-like sub-units in the quantosomes, transversally on chlorophyll layers.

This spatial localization of disjunct character of the chlorophyll and the soluble proteins is indicated also by the fact that materials or processes increasing or decreasing the chlorophyll level are often perfectly independent of changes in the protein level.

Except in the case of an extremely low or extremely high chlorophyll level, the intensity of photosynthetic carbon dioxide fixation changes proportionally with the soluble protein content of the chloroplast, which justifies the intensity of photosynthetic carbon dioxide fixation related to the specific activity on the level of soluble proteins.

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IS T. CARTHLICUM THE PRODUCT OF T. DURUM×T. AESTIVUM?

I have read the manuscript of Dr. Gy. Mándy "New concept of the origin of *T. aestivum* L.". I would like to make some observations on it.

1. Referring to Orlov (1923) the author considers durum wheat to be of South African origin. This is not so. According to N. I. Vavilov (1964) the origin of *durum* wheat is connected with the East Mediterranean.

2. According to the author's schema the origin of *durum* wheat is dated 1000 B. C. Russian triticologists, however, claim that there were traces of *T. durum* culture 3 or 4 thousand years B. C. (see K. Flaksberger 1934, M. M. Yakubtsiner 1956, 1957). According to N. I. Vavilov (1964) "the history of durum wheat culture is lost in the depth of millennia".

3. There can be found other unreliable data, namely: *a)* variety *T. georgicum* is wrongly described as being of North Caucasian origin; *b)* the hypothesis on *T. carthlicum* as a result of hybridization between durum and aestivum wheat is assigned wrongly to K. Flaksberger; as a matter of fact Flaksberger (p. 281) is against this assumption; *c)* the origin of *Triticum monococcum* is dated by the author about 9000—7000 years B. C., but the oldest findings of this species are from 7000; the date 9000 established by Rudorf (1968) must be queried; *d)* the assumption of neighbourly relation between the areas on which *urartu* and *Ae. speltoides* grew in Southern Caucasus does not correspond to the facts.

4. Some of the author's assertions lack a sufficient basis, namely: *a)* on the origin of *T. spelta* as a result of crossing between *T. carthlicum* and *Ae. squarrosa* (according to McFadden and Sears the *Triticum* parent was *dicoccoides* or *dicoccum*); *b)* on *turanicum* as an offspring of *georgicum; c)* on the special phylogenetical role of *urartu* wheat and its specific separation: as a matter of fact, this wheat is close to *T. beoticum* growing together with it in coenosis and according to N. I. Vavilov, K. A. Flaksberger, E. N. Sinskaya it is not worth mentioning as a species; *d)* on attributing seeds found in the excavations of Djarmo not to *T. dicoccum* but to *georgicum*.

5. Some lack of clarity can be found in the text: *a)* did Iranian spelta come into existence earlier than *aestivum* wheat or not; *b)* what is the connection between the area of *Ae. squarrosa* and the migration of *georgicum; c)* what is the origin of *ispahanicum* wheat?

6. In contradiction to the International Codex of Botanical Nomenclature the author offers classification schemes concerning the taxonomic units *T. boeoticum*, *T. dicoccum* conv. *iranicum* and conv. *vavilovi*. Besides this, the author's inconsistence is provable. On page 7 he rightly criticises MacKey for bringing together species which are highly different in their time of origin, but at the same time the author of the manuscript himself places the primitive wheat, *T. dicoccum* together with the species of *turgidum* and others. In particular I protest against placing the high diversity of durum wheat in the "bed of Procrustes" of a convarietas.

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WHAT DO WE NOT KNOW ABOUT WHEAT EVOLUTION?

The evolution of our crop plants is a fascinating subject. This is even more so because the histories of two of our most important cereals, wheat and maize, which ten years ago seemed to be well understood, are now known not to be so. Active research and debate are under way in an attempt to clarify the origins of both of these grasses, and in this respect Professor Mandy's paper "New concept of the origin of *Triticum aestivum* L." (Acta Agronomica Vol. 19, No. 3—4) is timely.

Professor Mandy does not report any new research. His paper is based on a re-interpretation of the existing literature, much of which he ignores, particularly that published more recently. Nevertheless, his paper does raise some important and interesting points with regard to wheat evolution, which are no less valid for his bibliography being uneven.

Professor Mandy's views are summarized in his "Sketch of the origin of wheat species, partly on the basis of the literature, partly by the author's concept." My first point of disagreement with Professor Mandy and, I fear, with many other people, is his acceptance of the hypothesis that *Aegilops speltoides* Tausch is the origin of both the donor of the B genome of *Triticum dicoccoides* Korn. and the second genome of *T. georgicum* Dekapr. (*T. palaeocolchicum* toen.). According to JOHNSON (1967) *T. palaeocolchicum* has a storage protein pattern similar to *T. timopheevi* Zhuk., although its meiotic pattern links it to *T. dicoccoides* (MATSUMURA—NEZU—KOSHIBA 1958). Evidence that *Ae. speltoides* is the source of the B genome of tetraploid wheat came from the work of SARKAR—STEBBINS (1956), RILEY—UNRAU—CHAPMAN (1958) and REES—WALTERS (1965). All three of these papers have the tendency to confuse a biotype with a species, although this is less of a criticism for the first paper, where as much material was studied morphologically as was available. However, the material available nowhere approached the full extent of the geographical range, nor the morphological diversity of any of the species concerned. Moreover, there is considerable doubt whether the method of extrapolated correlates (ANDERSON 1949) is able to distinguish a specific ancestor from among several morphologically similar contenders. Sarkar and Stebbins were aware of this, for they did not exclude *Ae. bicornis*, *Ae. sharonensis* or some as yet undiscovered *Ae. speltoides*-like taxon. They did not, however, entertain the idea that other diploid wheats might be the donors of second genome of the tetraploid wheats, as well as being the donor of the A genome. Diploid wheat, *T. monococcum* L., which includes *T. boeoticum* Boiss., *T. aegilopoides* (Link) Bal., *T. thaoudar* Reut. and *T. urartu* Tum., is morphologically a variable species with some biotypes having poorly developed glume teeth. Some wild collections of tetraploid wheat have glume characters which approach those of diploid wheat.

The karyotype evidence of Riley *et al.* has, perhaps, received the greatest amount of attention, even though their paper does not say how many biotypes of each species the authors looked at. That they looked at only a few biotypes appears probable, for they reported only one pair of chromosomes with satellites for diploid wheat. Nor did they mention that diploid wheat can have two pairs of chromosomes with satellites, despite there being many reliable reports of such a karyotype in the literature prior to 1958 (GIORGI—BOZZINI 1969). The karyotype studies of Waines and Kimber (unpublished) indicate that different biotypes of diploid wheat have variable karyotypes with one or two pairs of satellited chromosomes. There is also considerable variation in the size of the satellites, although as yet nothing so large as the satellites of tetraploid wheat has been found. In some biotypes the constrictions must be so terminal that satellites appear to be absent. *Ae. comosa* is another diploid species with a variable karyotype (WAINES 1969) and this fact poses the question of how much variability there is in the karyotypes of the other species. Rarely have a sufficient number of biotypes been looked at to ascertain the variability.

The paper of Rees—Walters (1965), who inferred evolutionary relationships from estimations of nuclear DNA, also suffers from being unclear with regard to the number of biotypes studied. It would appear that no more than one or two biotypes formed the basis for values attributed to the whole species. Intraspecific variation in DNA content has been found where it has been investigated (Nishikawa—Furuta 1969). One is left wondering in the absence of a thorough study of intraspecific variation in DNA content per nucleus in a wild species, whether this method is any more reliable than karyotype studies for deriving evolutionary relationships.

Tentative evidence that *Ae. speltoides* contributed the cytoplasm of the cultivated wheats (Suemoto 1968) has recently been contested by Maan (personal communication), who found that *Ae. speltoides* cytoplasm induced male sterility in combination with emmer and bread wheat genomes. A more thorough survey of the contenders for the source of the B genome of wheat is to be found in a recent review by Sears (1969). From this review and from the above, I conclude that we do *not* know the donors of the B and G genomes of the tetraploid wheats. At present, the most prominent candidates are (in alphabetical order) *Ae. bicornis, Ae. longissima, Ae. mutica, Ae. sharonensis, Ae. speltoides* and *T. monococcum*. Some of these diploids appear to have considerable intraspecific variability, contrary to the view of Zohary—Feldman (1962), and a thorough search within these taxa should be undertaken using all available biosystematic methods.

There is, as yet, no evidence that *T. urartu (T. monococcum)* contributed the A genome of *T. georgicum*. The single accession of *T. urartu* which I have studied does have a somewhat different storage protein pattern from the other known patterns for the diploid wheats. It is, however, too early to say whether this taxon has played a role in the evolution of the tetraploid wheats.

Another criticism of the scheme which Professor Mandy proposes is this: if *T. georgicum (T. palaeocolochicum)* has, as Johnson (1967) suggests, the protein pattern of the *T. timopheevi* complex, which is distinct from the Syrio-Palestinian race of *T. dicoccoides*, then quite a few mutations must have occurred for *T. carthlicum* and *T. turanicum* to have evolved from *T. georgicum*. Both *T. carthlicum* and *T. turanicum* have meiotic chromosome pairing and storage protein patterns characteristic of the Syrio-Palestinian race of *T. dicoccoides*, from which it is thought *T. dicoccum* and the cultivated emmer-type wheats were domesticated (Harlan—Zohary 1966).

If the cultivated emmers were domesticated from the wild *T. dicoccoides* stands of the upper Jordan Valley, as Harlan and Zohary suggest, and if they are distinct from the Turkey-Iraq-Iran race of *T. dicoccoides* (Sachs 1953, Wagenaar 1961, 1966), then cultivated emmer must have been carried by man over the fertile crescent to northwestern Iran and the Caucasus region for it to hybridize with *Ae. squarrosa* and form the amphiploid we know as hexaploid wheat. If, however, wild tetraploids with the characteristic protein pattern and chromosome pairing of the Syrio-Palestinian race of *T. dicoccoides* are native in the Caucasus region, then domestication might have taken place there in addition to, or instead of, in the upper Jordan Valley, and emmer would not have had to be transported to this area to hybridize with *Ae. squarrosa*.

The wild tetraploid wheat of the Caucasus area has been called *T. araraticum* by Jakubziner, for it is morphologically distinct from the Syrio-Palestinian *T. dicoccoides* and it has chromosome pairing affinity (Wagenaar 1961) and protein pattern affinity (Johnson 1967) with *T. timopheevi*. Recently Tanaka—Ishikawa (1968) have identified two types of *T. araraticum*. The first type forms fertile hybrids with *T. timopheevi*, while the second type does not. Nishikawa — Sawai (1969) measured the relative amounts of nuclear DNA in these two types and found that the first type has an amount of DNA similar to *T. timopheevi*, while the second type approached the DNA content of the *T. dicoccum*-type wheats. While screening biotypes of *T. araraticum* collected in the Caucasus area for protein pattern, Waines (unpublished) also came across two types, one with the pattern of *T. timopheevi* and the other with a pattern similar to the Syrio-Palestinian race of *T. dicoccoides*. Although meiotic chromosome pairing studies have yet to be undertaken, it does appear that the tetraploid wheats of the Caucasus area are a heterogeneous group, and there is the possibility that the Syrio-Palestinian race of *T. dicoccoides* is native there too. In this connection Professor Mandy's question regarding the identity of the carbonized grains found at archeological sites in Iraq is very pertinent. Did these grains come from plants which were descended from the populations of the upper Jordan Valley, or might they have been derived from plants closer by in the Caucasus-Iraq-Iran region? In other words, how thorough is our knowledge of the populations of tetraploid wheat in this area?

As to which tetraploid wheat or wheats hybridized with *Ae. squarrosa* to form *T. aestivum (T. vulgare)* and the other hexaploid wheats, we may be unable to answer. The reasons for this are adequately set forth by MAC KEY (1966), whose paper Professor Mandy does not appear to have taken fully into account. However, because of its protein pattern, it seems unlikely that *T. georgicum* was involved. In the above paper, Mac Key also discusses the interrelationships between the various kinds of hexaploid wheats.

There are still many blank areas in our knowledge of the present day distribution of diploid and tetraploid wheat. Not only have the large world collections not been investigated as thoroughly as they might have been, but some remote areas have yet to be covered. Contrary to what is to be expected from genetic theory, far too many workers in wheat think that because wheat is mostly self-pollinating, there is little intraspecific variation, and that one or two biotypes can be considered representative of the species. In fact the opposite ought to be, and appears to be, the case.

We ought to be wary of extrapolating too readily from the early cytogenetic and karyotypic work, which was undertaken before large collections of the wild species were available. For example, although Kihara's table of genome formulae for the genus *Aegilops* is a monumental work, it should be remembered that in most instances Kihara worked with only one or two biotypes of each diploid analyser species (KIHARA 1937, 1954). This fact, alone, might help explain the high proportion of "modified" genomes in tetraploid *Aegilops*, particularly in the tetraploids containing the M genome. Certainly *Aegilops comosa* (genome formula M) is a very variable diploid species. Kihara was aware of the limited number of biotypes in his collection, because he listed five possible explanations to account for the modified genomes, one of which was variation in the original diploid species (KIHARA 1954). In their work with storage protein patterns in the *Aegilops-Triticum* group, Johnson and Waines have found that the patterns can be very variable within the diploid species, are less variable within the tetraploid species (contrary to the views of ZOHARY—FELDMAN 1962) and are very similar within the hexaploid species.

The views expressed by Professor Mandy ultimately raise the question as to which is the most useful way of studying wheat evolution. In my view, each biosystematic method, morphology, anatomy, genome analys s (meiotic chromosome pairing), karyotype analysis, cytoplasm analysis and the various chemotaxonomic methods should be carried out on a geographically representative sample of the biotypes which comprise each species. Then the variability within and between the species might be assessed. The ancestors of a particular polyploid might be expected to be those biotypes which have more genetic information in common with the polyploid than do other biotypes. Therefore we need to know how reliable the various biosystematic methods are at estimating shared genetic information in a particular plant group. This will be a time consuming and laborious process, but without this knowledge we are unable to say that the evolutionary history of wheat, or any other plant, is well understood.

Finally, the question of the source of the B genome of wheat should be re-opened. We are only deluding ourselves if we think that the case for *Ae. speltoides*, or for that matter for any other diploid, has been proved beyond all reasonable doubt. There are still many questions to be answered with regard to species evolution in the *Aegilops-Triticum* group, and any original scientific investigation in this field should be welcome.

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HAS WEST GEORGIA PARTICULAR POSITION IN THE TRANSCAUCASIAN BREEDING GROUND?

Professor Mándy proposed an original conception concerning the origin of *Triticum aestivum* L. and a new evolutionary classification of the *Triticum* genus.

The problem of origin of the *T. aestivum* L. draws, at present, broad attention, because mastering the method of experimental formation of species allows to reconstruct the given species in the trend needed for production.

No less interest is evoked by problems of taxonomy of the genus *Triticum*, for in recent years our knowledge in the field of genetics and phylogeny of wheat has greatly increased and hence there is a possibility to approach the taxonomy of the genus *Triticum* in a new way. The increase is proved by the fact that during the recent ten years three new classifications of the genus have been published: Bowden (1959), Mac Key (1963, 1968).

All these allow us to consider the work of Mándy as representing broad scientific interest.

Mándy based his conception on the existence of two major primary breeding grounds of the wheat species:

1) Asia Minor, where formation of tetraploid wheat species *T. dicoccum* Schübl., *T. durum* Desf. and *T. turgidum* L. mainly took place, from eincorn *T. boeoticum* Boiss. and *T. monococcum* L. Here evolution of the genus *Triticum* ended, in principle, at the tetraploid point.

2) Transcaucasian (West Georgian), where hexaploid wheats (*T. macha* Dek. et Men., *T. spelta* L.) have been conceived and in particular *T. aestivum* L. species have been formed. Eincorn *T. urartu* Thum. and tetraploid species *T. georgicum* Dek. and *T. carthlicum* Nevski. served as the initial ones.

One can easily agree with the division of wheat species formation according to breeding ground. I should only like to emphasize that in the Transcaucasian breeding ground West Georgia occupies particular position. West Georgia, separated from East Georgia and the whole Transcaucasia by the Sourami ridge, is distinguished from other regions by high concentration of primary wheat species. Up to the present day the relic species of *T. timopheevi* Zhuk., *T. zhukovsky* Men. et Er., *T. georgicum* Dek. and *T. macha* Dek. et Men. have remained. An endemic for all Transcaucasian species *T. carthlicum* Nevski., or, according to the new classification *T. persicum* Zhuk.* also is well represented here. We also meet here *Ae. squarrosa* L., the source of "D" genome in hexaploid wheats.

I see the role of particular West Georgian species in the formation of soft Wheat as follows:

T. timopheevi Zhuk. and *T. zhukovsky* Men. et Er., with the genomic formula AAGG forms a lateral branch in the *Triticum* genus evolution and owing to the isolating mechanism (disynapsis) of species, *T. timopheevi* Zhuk. evidently does not take part in the formation of soft wheat.

Three other Georgian endemic species *T. georgicum* Dek., *T. macha* Dek. et Men. and *T. carthlicum* Nevski. in return played an important part in the formation of the mentioned species.

T. georgicum Dek., — *T. palaecolchicum* Men. has been located only in West Georgia and has never been found elsewhere. Archaeological excavations showed that it was cultivated here long ago — even in the Neolithic era.

It does not stand out by polymorphism (three variety), but it distinguishes from *T. dicoccum* Schübl. morphologically rather acutely e.g., by high density of ear (D = 44—50)

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* *T. carthlicum* Nevski. occurs in entire Transcaucasia, but stands out by the largest polymorphism and is most variably cultivated in Georgia.

that is provided by the zigzag structure of the rachis and by shortened ear scale. Morphologically it rather reminds stroud-eared forms of *macha*. On this basis Mackey considers it as a tetraploid parallel of *macha*-species.

According to the nature of meiosis *T. georgicum* Dek., as MATSUMURA *et al.* (1958) claims, shows relationship with *T. dicoccum* Schübl. and hence he puts it down as a subspecies of the latter.

A keen morphological similarity of *T. georgicum* Dekapr. with some other forms of *T. macha* Dek. et Men. allows us to assume, that it took part in the formation of this species.

T. macha Dek. et Men. is also a relic species for West Georgia. Notable for its relative polymorphism (14 varieties), it consists of two subspecies.

The first subspecies — ssp. *tubalicum* Dekapr. is characterized by friable and semi-friable ears with density coefficient (D = 24—23). In ear fragility it resembles *T. spelta* L. and the most friable forms have ears that split nearly as easily as that of wild wheat.

The second subspecies ssp. *imereticum* Dekapr. is notable for its dense and superdense ears with density coefficient (D = 35—57). By fragility it resembles *T. dicoccum* Schübl.

The most probable way of *T. macha* Dek. et Men. species formation is spontaneous interbreeding of tetraploid species and/or in this case *T. georgicum* Dekapr. with *Ae. squarrosa* L. with subsequent amphidiploidization. West Georgia, as noted above, is one of the areas for the latter species. That is why this kind of interbreeding could have occurred rather easily.

T. macha Dek. et Men. has also been found in West Georgia during the archaeological excavations and it has been believed to date from Neolithic era. Therefore, we can assume that *T. macha* Dek. et Men. has been formed earlier than wheat and is more ancient than *T. spelta* L.

We can completely agree with Mándy, that the origin of *T. aestivum* L. was polyphylatic and that this species was being formed in more than one point (polytonically) and repeatedly.

It seems to me that for the present we can accept the following four as the probable mode of origin of *T. aestivum* L.:

1) the first way of the formation of soft wheat is the amphidiploidization of *T. carthlicum* Nevski. and *Ae. squarrosa* L. hybrid.

As Mac Key proved, *T. carthlicum* Nevski. is a bearer of gene which provides light thrashing and strength of rachis, and wild cereal *Ae. squarrosa* L. is the source of genom D.

Areas of *T. carthlicum* Nevski. and *Ae. squarrosa* L. coincide. The latter occurs in high mountains and hence spontaneous interbreeding can be realized between *T. carthlicum* Nevski. and *Aegilops*, and it seems that it has been happening frequently.

This process could occur in every part inhabited by *Ae. squarrosa* L., as in Transcaucasia.

The genom structures of *T. macha* Dek. et Men. and *T. aestivum* L. are perfectly corroborated in works of an Estonian scientist IAASKA (1969), who showed, through electrophoresis, that *T. macha* Dek. et Men. took part in the origin of all hexaploid wheats.

2) As a result of interbreeding of *T. macha* Dek. et Men. with *T. carthlicum* Nevski. This interbreeding should result in nonfriable-ears with 42 chromosomes, for *T. carthlicum* Nevski. is a carrier of gene-Q, that provides nonfriability of rachis.

3) Through mutation of *T. macha* Dek. et Men. species — by means of small consistent mutations from *T. macha* Dek. et Men. species. The process has been realized in the following direction: firmly friable, firmly nonfriable, open, nonfriable.

This way of *T. aestivum* L. formation has been studied by Kuckuck on the example of Iranian *T. spelta* L. (KUCKUCK 1959). It may be probable for *T. macha* Dek. et Men., because very strong-eared forms occur frequently among these species.

4) And at last the fourth way of *T. aestivum* L. formation — interbreeding of *T. macha* Dek. et Men. forms with the primary *T. spelta* L. (originated by interbreeding of *T. dicoccum* Schübl. or some other tetraploid species with *Ae. squarrosa* L.). This way has also been studied

by Kuckuck on the example of interbreeding *T. spelta* L. species with Iranian *T. macha* Dek. et Men.* I have also intercrossed Iranian *T. spelta* L. with tight-eared forms of *T. macha* Dek. et Men. (ssp *imereticum*) and received a nonfriable form that is similar to a rigid *T. aestivum* L.

Receipt of nonfriable ear forms as a result of the two friable-stemmed forms interbreeding can be explained by the fact that Iranian *T. spelta* L. and *T. macha* Dek. et Men. contain genes q, and five doses, of q, have the same effect as two doses of Q.

The above-mentioned data demonstrate that in three cases soft wheat has been formed with the participation of *T. macha* Dek. et Men. and therefore with the participation of *T. georgicum* Dek. species.

To our regret we know little of phylogenetic interrelation between *T. georgicum* Dek. and *T. carthlicum* Nevski. And what we know does not show much similarity between them.

As it is mentioned above, among tetraploid wheats only *T. carthlicum* Nevski. is the bearer of gene Q, that provides cultural type of wheat.

T. carthlicum Nevski. — Dika (a Georgian name of this species) is a mountainous spring wheat cultivated mainly in Georgia. Black-eared form of Dika (v. *fuliginosum*) is found along the whole Southern slope of the Main Caucasian range, from Svaneti to Dagestan passing here and there over the Northern slopes. But black-eared Dika, apparently, did not take part in the origin of soft wheat. This happened with the participation of white-eared Dika (v. *stramineum*). It is wide-spread in Georgia and Armenia and is frequently met with as an admixture in Azerbaizan.

As for the origin of *T. carthlicum* Nevski., the alloploid nature of this species does not arise suspicion. It originated as a result of hybridization that took place long ago.

Vakar (1930) having investigated prairie forms of this species, came to the conclusion that species "Dika", the present form, is a quite balanced species.

Among tetraploid wheats, "Dika" *T. carthlicum* Nevski. shows the strongest similarity with *T. dicoccum* Schübl. and the great resemblance is noticed at the stage of earing. Percival related *T. carthlicum* Nevski. as a nonfriable selection of *T. dicoccum* Schübl. species.

Vakar (1932) having studied the meiosis of hybrid between *T. dicoccum* Schübl. and *T. carthlicum* Nevski. ascertained that most figures of meiosis give an idea of its erect course. It is necessary to point out still that the lag of chromosomes and flow of anaphase is not a rare phenomenon. Nevertheless hybrids form a wonderful full pollen.

On the basis of these data I venture to assume the existence of phylogenetic similarity between *T. dicoccum* Schübl. and *T. carthlicum* Nevski.

Parallelism between density of crops of these species, some kind of closeness between them and also their large polymorphism on the Southern slopes of the south Caucasian range and nearby areas, permit us to assume that this species has been formed from *T. dicoccum* Schübl. in East Georgia.

The principle idea of prof. Mándy that the primary origin of wheat took place in two breeding grounds (Asia Minor and Transcaucasia), is quite acceptable. We can also agree with the idea that there have been two ways of evolution in *Triticum* genus, and evolution in Asia Minor stopped basically at the tetraploid level. Other authors do not point out or underline this proposition.

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* Isolating mechanism between *T. macha* Dek. et Men. species (F_1 lethality as a result of hibrid necrosis) and other hexaploid wheats is not absolute. When being intercrossed with German *T. spelta* L., the forms of *T. macha* Dek. et Men. die as a result of hybrid necrosis, but they give rather normal posterity when intercrossed with the representatives of a spanish eco-morphological group of *T. spelta* L. (Dekaprelevich—Yashagashvili 1970).

Above-mentioned data about the role of definite wheat species in the origin of *T. aestivum* L. permit us to agree partially with Mándy's evolutionary classification. For final acceptance of this classification we have to specify the interrelation between *T. urartu* Thum. and *T. georgicum* Dek. species and between *T. georgicum* Dek. and *T. carthlicum* Nevski.

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IS T. DICOCCOIDES DIFFERENT FROM T. DICOCCUM?

The first sincere critic refers to his neglect of the tetraploid wild forms of wheat. They existed prior to cultivation and are definitely the progenitors of the cultivated emmers. *Dicoccum* evolved from *dicoccoides* like *monococcum* from *boeoticum.* The domestication processes run just parallel and in the Jarmo excavation both *monococcum* and *dicoccum* were found. They first took a somewhat different migration pattern, since einkorn was better adapted to highlands and cooler climates and *dicoccum* for lowlands and high fertility. They started, however, simultaneously, since they were both available to man at the onset of agriculture as was barley. I think Dr. Mándy is extremely alone in his idea that *dicoccum* evolved from *monococcum* crossed with *Ae. speltoides.* Today there are even people doubting *Ae. speltoides* as responsible for genome B.

Further, he appears to be completely unaware that he is discussing a genus including autogamous forms. They do not build up efficient species barriers, as they just do not need to do so for their preservation. Thus he denotes *vulgare* as separate species in spite of the fact that it crosses readily with *sphaerococcum* from which it differs by one single gene *s.* Further *spelta* differs also from *vulgare* by one gene *q.* The same is true for *compactum,* but here he suddenly ignores species borders. During the last wheat symposium in Canberra no single information was against my proposal (Mac Key 1966) but many did support exactly this delimitation.

He ignores botanical rules just a little too freely. *T. monococcum* is the correct name of einkorn, *T. turgidum* is the correct name for emmer just because Linnaeus happened to name them first, no other reason. I agree it does not make phylogenetic sense, but this is an entirely different thing.

Carthlicum is not related to *georgicum* but to *dicoccum* and *turanicum* from a phylogenetic point of view, but none of these types show any genetic divergence which should separate them into different species. His argument here is also astonishing, since *dicoccum* moved to the eastern area prior to the distinction of the *Q*-factor which is found in both *carthlicum* and vulgare. As these two forms always are together, where *carthlicum* is found, *i.e. carthlicum* is never alone, I would like to know how he can prove that *carthlicum* is older than *vulgare. Cf.* my discussion in Mac Key (1966). I would also like to see a proof that *carthlicum* developed from *georgicum* (a nomen illegitimum, should be *palaeocolchicum*) and not from *dicoccum. Palaeocolchicum* is connected with *macha* as is carthlicum with *vulgare* and the two groups have two different uses. The former for porridge, the latter for bread.

Dr. Mándy also groups the spelt wheats in a very strange way. *Spelta* is one species, and *macha* and *vavilovi* are subtypes under *vulgare* which latter type just is distinguished by having *Q* in contrast to *spelta, macha* and *vavilovi* which have *q*. This just shows the impossibility to set species borders inside *T. aestivum* L. (Thell).

I would also like to have an explanation why *T. dicoccoides* makes a separate *species* from *T. dicoccum*, when *monococcum* and *aegilopoides* and *thaoudar* do not. My impression would rather be opposite, but in no case the domestication process has brought the cultivated form so far from the wild one that we can discuss a true speciation process.

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HAS ONLY AE. SQUARROSA MONOPOLY ROLE IN THE FORMATION OF HEXAPLOID WHEATS?

Triticum L. is one of the most studied plants. It was the object of intense investigations by botanists, geneticists, plant-breeders, cytologists and plant growers. Many monographs have been devoted to it, but, nevertheless, still much remains unsettled. In particular, the main investigations in genus phylogeny and taxonomy need authoritative revision. It should be especially mentioned that the number of wheat species and their succession are so far unestablished. There are no precise criteria for determination of specific rank: one and the same form is assumed by some to be a good species, by others a subspecies, or new varieties are introduced (convarietas). Some see a species where in fact it does not exist, or exists only in the researcher's laboratory. In general, two extreme tendencies in classification of wheat are observed: representatives of one trend (who may be conditionally called parcellers) are busy with artificial creation of species within the genus, while others (who may be called liquidators) are occupied with liquidation of species, which are prospering, have their history, antiquity, geography and are practically well-known species.

We deal in our work with the investigation by Gy. Mándy — New concept of the origin of *Triticum aestivum* L.

There is no doubt that the reconstitution of a natural system of any plant (including, certainly, wheat) is attainable, if genetic structure of the genus and history of its evolution were comprehended. The experimental data of our laboratory convince that it is possible to repeat (reproduce) the phylogenetic process of such species as *Triticum carthlicum*.

T. polonicum, *T. monococcum*, *T. timopheevi*, *T. zhukovsky*, *T. timonovum* (laboratory species), *T. durum?*, *T. aestivum?*, *T. vavilovi*, although repetition in biology is denied by many people (V. L. MENABDE. New in phylogeny of the genus *Triticum* L., in print).

At present, priority of a Front-Asian nidus of wheat formation is well-grounded. The theory of Front-Asian origin of wheat has been well argued by Soviet triticologists and is now shared by many. Those, who deviate from this theory deviate from the natural system of the genus *Triticum* L. and are carried away to the region of speculative conjectures.

In Mándy's concept of the origin of *T. aestivum* the theory of Front-Asian origin of the genus *Triticum* L. seems to be reflected only partially. Thus Mándy attributes *T. durum* *T. turgidum*, *T. polonicum* to the regions of Abyssinia, Egypt and Northern Africa. At present it is established, that these areas represent a secondary (but not a primary) nidus of tetraploid species formation. It is true that there was a time, when even Vavilov considered these areas as a primary nidus of species formation, but later he abandoned his erroneous concept and accepted only one Front-Asian primary nidus of wheat formation.

The author, after analysing in detail the possibilities of the origin of hexaploid species is inclined to think that this process could arise only in the region of Transcaucasia, where areas of wheat and aegilops meet. It is here also that spontaneous intergeneric hybridization, concretely the hybridization between the species *Triticum carthlicum* and *Aegilops squarrosa* occurred. Hybrid plants arising from the crossings of these species, underwent later amphiploidization and gave a fertile posterity belonging to hexaploid wheat species *(T. aestivum)*. The author declares that "this theory is to-day generally agreed upon, but it is the mode of origin of *T. carthlicum* that has not been clarified as yet". And after a little excursion into the history of tetraploid species *T. carthlicum*, *T. dicoccum*, *T. palaeo-colchicum* (syn. *T. georgicum*) Mándy makes a conclusion, that it seems highly probable that *T. georgicum* was the progenitor for *carthlicum*, while the progenitor for the latter was an amphiploid plant, produced as a result of spontaneous crossing of wild diploids *T. urartu* and *A. speltoides.*

In the idea of Mándy, the formation of main tetraploid wheat species, which have the greatest economic importance *(T. durum*, *T. turgidum*, *T. polonicum)* occurred in Abyssinia, Egypt and N. Africa as a result of mutation of *T. dicoccum*. It took place 2000—1000 years B. C. (or even later). But these concepts of Mándy are contradicted by archeological data. Thus, hard wheat, according to JAKUBZINER (1957, 1962), was cultivated in USSR (Ukraine) as long ago as in the 4th millennium B. C. The antiquity of the turgidum wheat has also been confirmed (the 3rd mill. B. C.).

Further, the zone of distribution of the above-mentioned tetraploid species (warm climate, height above sea level and absence of *Ae. squarrosa*), as it seems, prevented their further evolution and therefore the initial species *(T. dicoccum)* in this group of wheats could not rise above the tetraploid level.

But the present day area of *T. dicoccum* is not limited to a warm zone. To-day, crops of this wheat are situated mainly in high-mountain regions up to the uppermost limits of wheat cultivation, so there is no reason to restrict the cultivation of *T. dicoccum* to zones of warm climate.

Mándy distinguishes two trends of evolution in the origin of cultivated wheat: one of them (in Asia Minor) stopped at tetraploid level and passed from *T. monococcum* to *T. dicoccum* — *T. durum*, *T. turgidum*, *T. polonicum*, while the other trend (Transcaucasian) originated from *T. urartu*, out of which developed *T. georgicum*, *T. carthlicum*, *T. aestivum.*

In both cases wheat evolution is conceived with active participation of *Aegilops speltoides* and *Ae. squarrosa.*

The first evolutional trend stopped in its development at tetraploid level, whereas the second reached hexaploid level. According to MÁNDY (1970), both trends developed autonomously and independently.

We agree entirely with the concept of hybridization origin (in combination with phenomena of autoploidy and mutation) not only of hexaploid, but tetraploid wheat species as well, such as *T. durum*, *T. turgidum*, *T. polonicum*.

In wheat evolution a great role belongs also to autoploidy and to mutation. But we differ in our conception of the trend of evolution of the genus *Triticum* L.

In the first place, we regard two trends ascertained by Mándy, as an indivisible process proceeding consistently and not autonomously. Artificiality (unreality) of the scheme is mainly in the dissociation of these two evolution trends. It is true, that we too distinguish two trends in the evolution of wheat, but their content differs radically from the concept by Mándy. We shall speak later about this.

In the whole, Mándy conceives the development of hexaploid wheat species on the basis of spontaneous intergeneric hybridization of *T. carthlicum* and *Aegilops squarrosa*, their sterile hybrid plants becoming fertile by way of amphiploidization. This concept is confirmed by the fact, that *T. aestivum* has been obtained by crossing the above two species (KIHARA—LILIENFELD 1949). Against the reality of this concept stands the life-history of the species *T. aestivum* and *T. carthlicum*. The former is a relatively primary species, while the latter *(T. carthlicum)* is a relatively young, secondary species, produced as a result of mutation of hard wheat under mountain-forest conditions. This process of mutational formation of *T. carthlicum* from cultivated *T. durum* under mountain conditions has been experimentally verified and to-day we have a model, according to which the process of reconstruction of this species is reiterated. Mutational process in the hard wheat populations arises, evidently, under concrete conditions of mountain climate (probably, under the action of elevated radiation) and definitely in *T. durum* populations. Already FLAKSBERGER (1935), putting forward the mode of formation of *T. carthlicum*, remarked that, probably "hard wheat *T. durum*, ascending in Transcaucasia up the mountains, was differentiated in the process of evolution . . . and . . . in such a way was produced a vicarious species, which replaced hard wheat in high-mountain conditions" (FLAKSBERGER 1935).

Flaksberger, with admirable precision and intuition, foresaw the process of formation of *T. carthlicum*, which has been experimentally borne out by us as a result of mutation of two forms of hard wheat, *T. durum* v. *apulicum* and *T. durum* v. *libycum* under mountain-forest conditions of cultivation at 1500—1700 m above sea-level. Under the same conditions of mountain climate the appearance of peculiar wheat forms has been established in populations of hard wheat that was called by Vavilov as "*persicoides*", i.e. *carthlicum* like forms of wheat. We did not hear that an *identical* process was going on, evidently, in mountain regions of Abyssinia, where *carthlicum* like forms of hard wheat were recorded.

Vavilov believed, that hard wheat *(T. durum, T. turgidum)* was the main cereal of agricultural Mediterranean civilizations, which, spreading out later to many regions of the Old World, was differentiated in a complicated manner into subspecies. In Transcaucasia hard wheat occupies the steppe part of land cultivation, its altitudinal border of cultivation being situated at about 1000 m above sea-level. Above that line it is replaced in Georgia by *T. carthlicum*. Thus, *T. carthlicum* is a vicarious species of hard wheat, being a secondary one, which arose in the "bowels" of hard wheat. The antiquity of the latter has been confirmed by archeological findings. In particular, Tripolien culture (USSR) dating back to 3000—1700 B.C., knew agriculture, cultivated wheat and was acquainted already with hard wheat.

According to Mándy, *T. carthlicum* arose from *T. palaeo-colchicum (T. georgicum)* as a result of mutation.

Structurally this species is very near to the species of hard wheat and its morphological distinction consists of fragile stem and hulled grain. But in evolution *T. palaeo-colchicum* is more ancient, and phylogenetically closer to wild wheats (hulled grain, fragile stem), whereas *T. durum* is a typical representative of highly cultivated wheat produced through hybridization, with the participation of *T. palaeo-colchicum.* Both species, *T. durum* and *T. carthlicum*, proceeded from the same phylogenetic line, at the base of which lies *T. durum*, *Tr. carthlicum* being its continuation (See our Phylogeny of Wheats).

According to Mándy's concept, formation of hexaploid species proceeded polyphyletically and through hybridization. This principle ought to be accepted. Polyphyletism in the origin of soft wheats was noted by many triticologists (SINSKAYA 1955). According to our data, polyphyletism is characteristic of other wheat groups too. Mándy names two nidi of hexaploid species formation: 1) *T. carthlicum* × *Ae. squarrosa* = *T. aestivum*, and 2) *T. turanicum* × *Ae. squarrosa* = *T. sphaerococcum* and *T. spelta iranicum*. Both the nidi are situated in the *Aegilops squarrosa* habitat.

In general, according to the author, hexaploid wheat species could develop only in the area of *Ae. squarrosa.* Our laboratory does not dispose of any data confirming the monopoly of *Ae. squarrosa* in the formation of hexaploid wheat species.

First of all, it seems to us, that the process of species formation proceeded on the whole under certain influence of primitive men. At the same time, this process was carried out in a complex community (coenosis), consisting of a group of congenerous cereals *Triticum*, *Aegilops*, *Agropyron* and probably, *Secale.* In such a complex coenosis an intense process of natural hybridization occurred, most characteristic of all cereals (today among the cereals over 50% of hybrid species have been recorded).

Process of hybridization engaged all the population of the community, occurring within the species, between species, as well as between the genera of related cereals. The intensity of this process gradually increased with the extension of the number of hybrid plants (our data demonstrate a significant intensification of natural hybridization among hybrid plants). In such a complex coenosis introgressive hybridization regularly proceeded and together with the process of ploidization, intensive formation of new plants took place. In the habitat of these useful plants man too lived, who enjoyed the gifts from the surrounding plants. His attention, naturally enough, was drawn to larger plants with large nourishing grain. Such plants possessing the properties of wheat were gathered, selected, stored and finally domesticated.

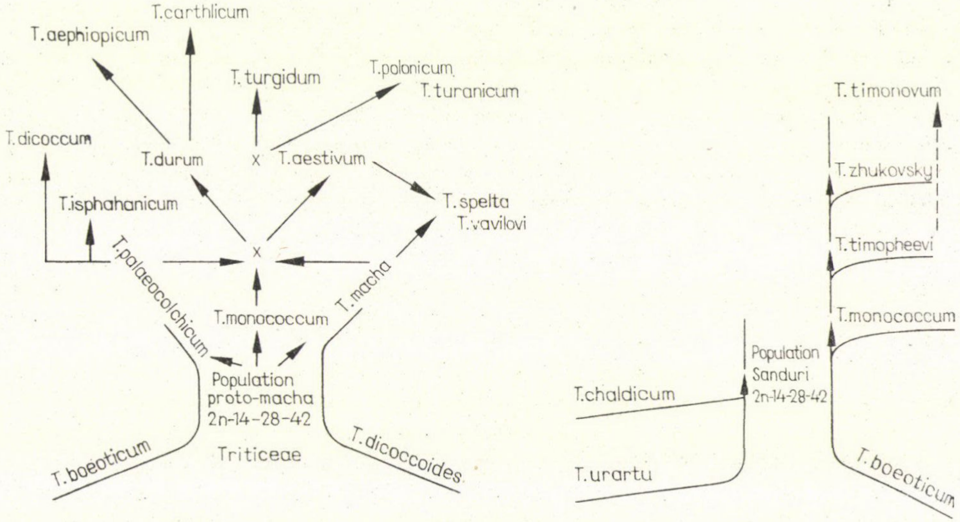

Fig. 1. Phylogeny of wheats

Therefore, the primitive cultivator already disposed of a complex coenosis consisting of monoploids, 14—28—48 chromosomes, forms of wheat and other weeds. He drew from this coenosis and improved various wheats. It appears to us, that cereal wealth of primary land-cultivator, since old days, had a complex population. In that population the processes of natural hybridization and introgression were periodically repeated, as well as formation (divergence) of plants (species) of wheat with different ploidy with the interference of the man-cultivator took place. In such a way gradually arose an anthropogenous, complex polyploid population, conditionally named *T. proto-macha* (MENABDE 1948). That was the principal population, on the bases of which the process of divergence proceeded under the influence of elementary modes of selection.

According to our concept, in that population were formed the diploid species *T. monococcum*, tetraploid species *T. palaeo-colchicum*, *T. dicoccum*, *T. durum (T. turgidum)*, *T. carthlicum*, *T. polonicum*, and hexaploid species *T. macha*, *T. aestivum*, *T. spelta*, *T. sphaerococcum*.

Therefore, *T. proto-macha* represents that main tree upon the rich crown of which developed the specific varieties of wheat. From that tree, growing in the agricultural nidus of Front Asia, the wonderful cereal-wheat migrated all over the world. That process was carried out under the control of popular selection. At the same time, the process of divergence also proceeded.

Besides that main tree, we have revealed in the system of wheat a tree of lesser size, but very interesting in its formation, which developed apart from the main tree. It is quite possible that by age it is much younger than the main tree. At the base of this tree lies the Georgian population "Zanduri" consisting of diploid, tetraploid and hexaploid plants — *T. monococcum* (2n = 14), *T. timopheevi* (2n = 28), *T. zhukovsky* (2n = 42). *T. boeoticum* (or *T. urartu*) must be considered as its initial link, which by way of ploidization, under natural conditions, produced *T. chaldicum* (syn. *T. araraticum*), and in agriculture (through *T. monococcum* AA) autotetraploid *T. timopheevi* (AAAA) and autohexaploid *T. zhukovsky* (AAAAAA) arose.

Zanduri is one of the most ancient populations reported as early as 1773 by well-known naturalist Güldenstedt (MENABDE 1948).

Development of all the components of population proceeded monotypically owing to, as we believe, homogeneity of the population content. Every polyploid species *(T. timopheevi, T. zhukovsky)* was a polymerous form of the initial monomer — *T. monococcum*, which has in its structure one pair of AA genoms. That conclusion has been borne out by us experimentally, by means of mutational reconstruction of polyploid *T. timopheevi*, *T. zhukovsky*, and *T. timonovum* from the diploid species *T. monococcum* (a component of Zanduri population). It appears to us, that production of polyploid by means of induced mutation is a convincing model illustrating the processes of natural polyploidy.

Under natural conditions the evolution of autoploid branch stopped at tetraploid level (*T. chaldicum*, alias *T. araraticum*, 2n = 28, AA AA), while under cultivation (in agriculture) it attained hexaploid level (*T. zhukovsky*, 2n = 42 AAAAAA). Under laboratory conditions, by means of induced mutation of *T. timopheevi* (2n = 28, AAAA) an octoploid (2n = 56 AAAAAAAA) — *T. timonovum* was obtained (HESLOT 1959). In comparing the rates (the intensity) of evolution, it may be remarked, that in natural conditions the intensity of evolution is relatively retarded, while in agriculture it is increased.

Thus, polyploidization of Zanduri is somewhat similar to that of *proto-macha*, polyploid species of these populations being, however, sharply different in genotypes. That difference may be accounted for by different trends in wheat evolution. It has been already told, that evolution of the first (and main) trunk (*proto-macha* population) proceeded through intense alloploidy, structurally enriched with hereditary substances of many genera of *Triticeae*. On the whole, the genom structure of this trunk is a polytype one, of complex hybridity, whereas the structure of the second trunk (Zanduri population) is monotype, consisting of a unique, though polymer genome. But in spite of monotype character of the members of Zanduri population, its autoploid species *(T. timopheevi, T. zhukovsky)* are sharply different from the initial diploid species *(T. monococcum)* of their population. In the concept of Müntzing "... in autotetraploids a sharply pronounced barrier of incompatibility exists between the initial diploid forms and the new lines with doubled chromosome numbers" (MÜNTZING 1951).

Evidently, the doubling of genome (chromosome set) is not only a quantitative process but a qualitative one too, as quantitative changes in genome bring about new qualities. These qualitative changes lead, in particular, to sexual isolation of autotetraploid species from the initial diploid one. Apparently, the sexual isolation of autoploids is biologically advantageous, as it ensures the existence of several sympathic species in the same population.

Experimental polyploidy definitely cleared up a number of problems in the evolution of some species in the genus *Triticum*. Thus, to the present day we have succeeded in reconstructing the experimental models of Zandur population, of its polyploid species *T. timopheevi* (2n = 28), *T. zhukovsky* (2n = 42) and *T. timonova* (2n = 56).

We were enabled to comprehend the ways of mutational formation of *T. carthlicum*, after the example of which, apparently, proceeded the formation of Abyssinian wheats too. The hybridization way *(T. durum × T. aestivum)* of formation of *T. polonicum* has been revealed, and it seems that the formation of *T. turanicum* followed the same path. In our laboratory the corresponding models of reproduction of the above-mentioned species have been practically substantiated. There exists an outline of the models for such species as *T. aesticum, T. durum, T. macha.*

The available literature and factual material obtained after many years of experimental research, permit to represent the genealogy of the genus *Triticum* by a two-trunk tree having unequal development. The first, the more powerful trunk, arose as a result of intense introgression and amphiploidy endowing human beings with the principal species of cultivated wheat. As a result of repeated introgression, mainly of the genera *Triticum* and *Aegilops*, as well as of interference by the human consumer and cultivator of cereals, an anthropogen polygenome population arose, which we have named, conditionally, as *T. proto-macha.*

In the course of human selection activities and of human migration population *T. proto-macha*, consisting of di-, tetra-, and hexaploid species, was differentiated into separate species, geographical races and populations.

The formation of the second trunk occurred through autopolyploidization of diploid wheat — *T. boeoticum*, or *T. urartu.* Under natural conditions, the autoploid process reached tetraploid level (*T. chaldicum*, 2n = 28, AAAA) only, while in agriculture it attained the hexaploid level, beginning with the diploid *T. monococcum* (2n = 14, AA) through tetraploid *(T. timopheevi*, 2n = 28, AAAA) and ending in the hexaploid one *(T. zhukovsky*, 2n = 42, AAAAAA).

The autoploid process in cultivation proceeded in the population of Georgian wheat Zanduri independently from the population of *T. proto-macha*. Polyploid line of Zanduri stands quite apart from ploid species of *proto-macha* population. Phylogenetic difference among polyploid (tetraploid, hexaploid) species is very pronounced, while it is absent among diploid species *(T. boeoticum, T. urartu, T. monococcum)*, having only one genom AA with chromosome set 2n = 14 in their structure.

Thus the genetic hiatus between the species of these two trunks begins at their tetraploid branches.

On the basis of the experimental data, obtained in our laboratory, we propose a new scheme of phylogeny for the genus *Triticum* L. essentially differing from Mándy's scheme.

The proposed scheme does not, of course, claim to be complete, but we believe, that it faithfully depicts the historical way of evolution of cultivated wheats.

According to Mándy's classification, there are only 10 species in the genus, others being brought down to the category of convarietas. Mándy is very sparing in the statement of the principles of his classification, that is why the review of the list of taxa arouses some confusion. Thus, on what ground the author ranks *T. timopheevi* as a species, while bringing down its wild analogue, *T. chaldicum* to convarieties? It is to be supposed, that *T. chaldicum (T. araraticum)*, as a wild species, is not younger, than the cultivated species *(T. timopheevi)*, hence the rank of species should be kept for it as a structural element of natural flora. Transfer of such good species as *T. macha*, *T. durum*, *T. carthlicum*, *T. vulgare*, *T. sphaerecoccum*, *T. polonicum*, each characterized by a complex of morphological, eco-geographical, cytological and economic properties to the category of convarieties, is also unjustified. We have a special objection to the inclusion of *T. macha* into the composition of *T. aestivum*. According to Vavilov's expression, macha is a semi-wild wheat preserving pronounced characters of wild wheat, therefore, as one of the basic species of initial culture, it is eligible for the rank of a species.

Consequently, the concept proposed by Gy. Mándy is too artificial and does not reflect the real history of genus formation, in particular of its hexaploid species (Table 1).

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HOW DID WHEAT ORIGINATE?

Origin, spread and domestication of wheat are questions dealt with all over the world (SCHIEMANN 1947, 1951, KIHARA 1958, KIHARA *et al.* 1959, KUCKUCK 1959, CHING-JANG YÜ 1961, ZOHARY 1963, KIMBER—RILEY 1963, LELLEY 1963, ANDREWS 1964, MAC KEY 1963, YAMASHITA 1964, HALLORAN 1968, RUDORF 1968, ZOHARY *et al.* 1969, MÁNDY 1970). According to the evidence of recent excavations the wild *T. monococcum* arose in Asia Minor before the neolithic period (OPPENHEIMER 1963). Apart from the earlier described *T. boeoticum* Boiss., *T. urartu*, the most primitive form of wheat was described by Tumanov in 1937; it is at the same time the progenitor of the tetraploid *T. georgicum* (ZHUKOVSKY 1957). This fact hints at the idea that in addition to the above-mentioned progenitors there might have been a no longer existing species which represented the very first step in the developmental process of wheat.

MÁNDY's (1970) suggestion enriches the existing theories about the origin of wheat with new ideas. In his opinion the hexaploid *T. vulgare* originated from the crossing and amphiploid mutation of the tetraploid *T. carthlicum* × *Ae. squarrosa. T. carthlicum* is, in turn, a more productive mutation of the primitive *T. georgicum*. According to Mándy *T. dicoccum* cannot be considered as the progenitor of hexaploid wheats, since its place of origin did not coincide with the area of *Ae. squarrosa* and so could not enter into hybridization with it. His arguments seem to be reasonable; he explains that *T. dicoccum* spread southward and westward from its place of origin, and it is highly improbable that in the 7000 years B. C., it would have spread from Asia Minor to Trans-Caucasus, in a direction opposite to the great migration. Archeological excavations so far support Mándy's theory, since — while *T. dicoccum* and *T. aestivum* were found in areas of Turkey — *T. spelta* was not found there. *T. spelta* appeared 2—3 thousand years later and originated from neither *T. dicoccum* nor *T. dicoccoides*. That is why Mándy thinks that the hexaploid wheat species may have developed in more than one ways.

According to our present knowledge Mándy's description of the origin of *T. aestivum* is correct, and he easily points out FLAKSBERGER's (1935) error (cit. MÁNDY 1970). His explanation on the possible way of development and spread of *T. carthlicum* is logical and clever. Mándy describes the origin of *T. durum* after ORLOV (1923) and VAVILOV (1926) (cit. MÁNDY 1970) as follows: "*T. durum* developed, on the other hand, in North Africa — not earlier than in the Bronze Age". Indeed, *T. durum* is quite a young species, though its place of origin is not North Africa, but Anatolia as proved by Kuckuck in 1964. It is sure, however, that the oldest remains of *T. durum* were found in Egypt, so the recent durum of Asia Minor does not prove its origin from there. So the question continues to give rise to much controversy.

T. dicoccoides has been found to have its greatest variability today in its secondary places of distribution: Syria, North-Palestine and Jordan (YAMASHITA—TANAKA 1961, YAMASHITA 1964) and not in its centre of origin: Asia Minor. *T. dicoccoides* was first discovered by Kotschy in 1855, then again by Aaronson in 1906 in the northern part of Syria, in a cleft at the edge of the mountain Hermon. This mountain range was visited again in 1964 by a Japanese expedition which found that *T. dicoccoides* is a wide spread species in that region even today. According to Täckholm, director of the Agricultural museum of Cairo (YAMASHITA 1964) the oldest *T. dicoccum* grains found in the pyramids are 6500—7000 years old; these facts support Mándy's theory because *T. spelta* was not found in these excavations, only much later in the Bronze Age and then only in Europe. On the other hand, this does not mean that *T. spelta* is of European origin; according to Mándy's theory it might have originated in the northern regions of the Caucasus and then migrated westward through the Ukraine as far as to Switzerland. Mándy thinks *T. georgicum*, *T. carthlicum* or *T. turanicum* to be the immediate progenitor of *T. spelta*, and not *T. dicoccoides* and *T. dicoccum* which — in his opinion — have remained as tetraploid species and has not attained higher ploidy levels. His theory and conclusions are reasonable, but the correctness of his statements will supposedly be confirmed by sufficiently explored excavations in Central Asia, new expeditions and — perhaps — by experimental genetics. KUCKUCK (1959) found *T. spelta* to be widely spread in Iran which justified an archeological research work started in those areas. The present excavations are not sufficient yet to prove that *T. spelta* appeared at the same time as common wheat. Recent archeological research will certainly provide new data on this species having possibly originated in that region.

As to the development of tetraploid wheats Mándy accepts in his paper the Aegilops speltoides-theory, although the origin of the B genome is questionable even in these days (SEARS 1968). We only know that BB genomes of the tetraploid emmer are not identical with the AA genomes of *T. monococcum*. Thus, the tetraploid wheat is not autopolyploid. First Ae. bicornis, then *Agropyron triticeum* were suspected; recently — after the experiments of KIHARA (1944), SARKAR—STEBBINS (1956), SEARS (1959) and RILEY—CHAPMAN (1958) — BB genomes are thought to originate from *Ae. speltoides.* In the gene centre of *T. monococcum*, YAMASHITA (1964) found 16 species in addition to the earlier known *Aegilopses*, which all might have crossed with the *T. aegilopoides* and thus taken part in the development of first tetraploid, then hexaploid forms. Most of the *Aegilops* species can be found in Jordan, Lebanon, Syria, Turkey and Greece. *Ae. bicornis* and *Ae. ventricosa* have been found only in Egypt. An almost certain clarification of the origin of the B genome can be expected in the near future, since a number of research workers all over the world are pursuing, at present, after the source of the B genome. Among Hungarian research workers BELEA's genetical and cytological experiments are of importance in this field (1965, 1968).

As to Prof. Mándy's theory and logical trend of thoughts, there are some recent contradictory results. According to ANDREWS (1964) *T. spelta* was found in Iran as early as in 4000 B. C. Its wild form may have originated from the crossing of *T. dicoccoides* × *Ae. squarrosa*. Its development is thought to have taken place in the south-western part of Asia, as it is one of the native places of *T. dicoccoides* and *Ae. squarrosa* (South Armenia, North-East Turkey, West-Iran, Syria and North Palestine). The other case, namely that *T. dicoccum* was one of the parents of *T. spelta* can also be supposed. In that case it arose, in all probability, in the course of cultivation. It can be supposed, however, that *Ae. squarrosa* really appeared here sporadically only later, and had been found originally eastward from the Caspian Sea. It is an open question which can be decided primarily by the excavations.

It is already known that Vavilov's law of dominant genes being the most frequent in the genes centre and recessive genes prevailing when moving off — is not always true. According to KUCKUCK's (1964) investigations the gene centre of tetraploid wheats is in Anatolia.

Papers by KIHARA (1944), MCFADDEN—SEARS (1944) on experimental evolution do not support Mándy's theory. It was in 1944 that Kihara first suggested the logically possible origin of *T. spelta*, then MC FADDEN—SEARS (1944) confirmed Kihara's theory. They produced *T. spelta* by crossing *T. dicoccoides* with *Ae. squarrosa*. In 1949 Kihara similarly obtained *T. spelta* by crossing *T. dicoccum* and *Ae. squarrosa*. Artificially resynthetized amphiploids proved to be morphologically, cytologically and genetically identical with the natural spelta wheat. With their work KIHARA (1944), then MCFADDEN—SEARS (1944, 1946) experimentally proved the genetic origin of *T. spelta*. Genetical experiments have not confirmed so far the supposition of *T. carthlicum* being the possible progenitor of *T. spelta* either. While the earlier mentioned tetraploid wheats, when crossed with *Ae. squarrosa*, result in *T. spelta*-type hexaploid wheats, from *T. carthlicum*×*Ae. squarrosa* hybrids *T. aestivum*-type wheats can be produced (TSUNEWAKI 1968).

According to MÁNDY (1970) the parallel wild relative of *T. dicoccoides* far eastward is *T. georgicum*, and in his opinion it is from latter that the *spelta* wheat of that region developed.

All *spelta* wheats are hexaploids with 42 chromosomes. In this series no wild species can be found. Asia Minor is supposed to be the place of origin of *spelta* wheats. *Triticum aestivum* ssp. *aestivo compactum* — the progenitor of the series — has already been found near human settlements of the Stone Age. In the neolithic period this was the widest spread hexaploid wheat in Central Europe. As no wild species can be found in the hexaploid line it is probable that members of the species were introduced to cultivation as soon as they arose. It is beyond doubt too, that the extraordinary variability of this species was promoted by human intervention.

However, the origin of the B genome, as well as the origin and spread of *T. spelta* are questions to be decided on the basis of recent suggestions by MÁNDY (1970), ZOHÁRY *et al.* (1969), KIHARA (1944), KUCKUCK (1959, 1964) and MCFADDEN—SEARS (1946). The Japanese expedition (YAMASHITA 1964) revealed that the area of *T. dicoccoides* and *T. dicoccum* coincided with the western and south-western zones of the *Ae. squarrosa* distribution. KUCKUCK (1959, 1964), on the other hand, found *T. spelta* on a large area in Western Iran, and *T. dicoccum* on a somewhat smaller area. Origin of the *T. spelta* and genome B can be finally determined only if the above results are confirmed by further expeditions, archeological examinations and genetical and cytogenetical evolution experiments.

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DID T. SPHAEROCOCCUM ORIGINATE THROUGH HYBRIDIZATION?

I find that the author has proposed several interesting ideas. He has also emphasized the need for studying in greater detail the role of *T. georgicum* in the ancestory of wheat. Since he has not provided any experimental evidence in support of his views, I am not able to offer any critical comment. However, some of the ideas which he has mentioned in page 4 of the manuscript such as the mode of origin of *T. sphaerococcum* are not tenable since it has now been well established that this subspecies would easily arise by a mutation from *T. aestivum*.

I recommend the publication of this manuscript only because it will stimulate some others to do more experimental work on this very important problem.

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ARE FINE STRUCTURAL AND CYTOCHEMICAL STUDIES HELPFUL IN THE STUDY OF WHEAT EVOLUTION?

The approach applied by Professor George Mándy to clarify some interesting points related to the origin of *Triticum* ssp is welcomed. Although during the first half of this century, the evaluation of genome analytical data has produced very valuable concepts, it is now the general belief that a revision is necessary since ultrastructural studies have yielded an entirely new aspect concerning the conjugation of homologous chromosomes. It is hoped that the old and rather mystic concept which simply assumed an attraction between homologs will be replaced by the discovery of the synaptinimal complex with the clarification of its function. These discoveries clearly indicate that a highly specialized organelle is involved in synapsis. Thus, fine structural studies seem to open up a new outlook which may result in the entire evaluation of data collected by such excellent schools as Sax, Kihara, Sears, McFadden, etc.

In the light of these facts, we believe that other quite important approaches were not fully exploited. A full and final solution concerning the origin of cultivated plants cannot be expected until all anthropological, phytogeographical, and even palaeobotanical possibilities have been explored. Since Dr. Mándy tries to evaluate such data and to construct a new scheme based on bibliographical data and on his own evaluation, we believe that this approach has some strong points and valuable merits. Extensive excavations, phytogeographical studies and anthropocentrical aspects in these findings should be emphasized, as Dr. Mándy does it, until fine structural and cytochemical studies throw more light on the forces operating at the molecular level which attract and conjugate chromosomes. It is to be expected that the assembly of a highly specialized element or elements building up the synaptinimal complex must be genetically controlled and that the mode of control should also be clarified.

Thus, the rather mystical explanation of chromosomal attraction which was expressed over 40 years ago by Professor Zoltán Szabó "as microscopical love-making" will be scientifically interpreted. However, we believe that no complete picture will result without the clarification of geographical distribution of the involved species, their role in prehistoric time, and their interrelations with such anthropocentric aspects as human behavior. Thus, we fullheartedly welcome Dr. Mándy's approach utilizing such data.

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T. CARTHLICUM — DIRECT PROGENITOR OF VULGARE?

I agree with Prof. Mándy that ssp. *spelta* is older than ssp. *vulgare*. On the basis of my own experiments and results I found it very probable that ssp. *vulgare* originated from ssp. *spelta* through a series of micromutations, or through a duplication at locus q in chromosome 9. The evolution of ssp. *vulgare* could have taken place in both the ways mentioned above, which means that this subspecies is not of a monophyletic origin. These suggestions are further explained in two of my publications (Kuckuck 1964a, b).

There is no question of *T. carthlicum* (persicum) being a direct progenitor of ssp. *vulgare*. Its origin, like that of *durum* and *turgidum*, is still not clear, but one thing is certain, that it is of recent origin. I can not agree with Prof. Mándy's suggestion, that ssp. *carthlicum* has arisen from ssp. *georgicum*. *Carthlicum* probably originated from a cross between *vulgare* and *dicoccum*, or, according to Flaksberger, between *durum* and *vulgare*.

In this connection I would also like to refer to the fact, that the hybrid of *T. carthlicum* and *Ae. squarrosa* is barrel type, so ssp. *vulgare* cannot originate through amphidiploidization of this cross (KIHARA—LILIENFELD 1948).

I am of the opinion, that *turanicum* (orientale) is not a progenitor of *T. sphaerococcum*, and I support Percival's suggestion that *turanicum* is a hybrid of *T. polonicum* and *T. durum*. In the experience of both Dorofejev and myself, *turanicum* appears only sporadically. This variety is very sensitive to powdery mildew and blight, in complete contrast to *carthlicum;* so *carthlicum* has not arisen from *turanicum* either.

T. georgicum is not different phylogenetically from *T. dicoccum*. It is only a compact-eared variant of *dicoccum* which occurs in a mixed stand with *T. macha*, whose phenotype it resembles.

On the basis of my own crossing- and mutation-experiments, the suggestion that *T. macha* and *spelta* are two independent subspecies is not tenable today.

I would like to call Prof. Mándy's attention to the papers of DOROFEJEV (1969a, b) and ANDREWS (1964).

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HAS ARCHEOLOGY ANY ROLE IN THE STUDY OF WHEAT-EVOLUTION?

The main point of Professor György Mándy's work is its tracing back the cultivated wheat varieties in two lines (lines of *T. boeoticum* and *T. urartu)*. This theory is supported by ethnographic researches and archeological findings too, though they do not lay as a great stress on this point as Professor Mándy does. It might be useful if he considered H. Helbaeck's research work. I call his attention, further, to the study of Csitája written on the Caucasian agriculture and the ancient Caucasian wheat varieties and published in the yearbook of our Institute (Műveltség és Hagyomány, I—II). Since in essentials I agree with Professor Gy. Mándy's opinion, I consider any further comments as superfluous.

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IS WHEAT OF BIPHYLETIC ORIGIN?

A new, valuable study by the eminent expert of wheat was published in the Acta Agronomica XIX/3—4, in which — on the basis of his own and others' relevant results — the author threw a new light upon the origin and taxonomy of the genus Triticum.

The origin and taxonomy of wheat had earlier been dealt with by **Lelley—Mándy** (1963), **Lelley—Rajháthy** (1955), **Kiss** (1966), **Mándy—Mesch—Kiss** (1966) etc. to mention but a few of the Hungarian authors — and by **McFadden—Sears** (1946), **Kihara** (1949), **Flaksberger** (1935), **Mansfeld** (1951) etc. among the foreign authors. Since the problem partly falls within my sphere of interest [the first text-book on genetics was written in Hungary by me as early as in 1935: "Bevezetés az öröklestanba" (Introduction to genetics)— **Greguss** 1935], I undertook giving my opinion about the paper on the request of the editorial office.

In my general opinion the paper was written on the basis of a wide and thorough knowledge of the subject and the relevant literature, and data and arguments presented in it agree with the present views of science. It is only too natural since the author had already published several valuable papers on this subject, e.g. compiled a taxonomic key for the determination of wheats, gave brief morphological descriptions of about 72 wheat varieties in another paper of some length, etc. This time the author tried to clarify the origin of the genus *Triticum*, first of all, with a view to bring views on the origin and taxonomy of wheat species to order. (I think the author should have indicated the subject at least in a short introduction.)

As to its size the paper seems to be a little short, since — in our opinion — this important subject is worth being discussed in more detail, especially where distribution and overlapping of the individual species are dealt with and where a number of sketches would have supported the author's reasoning to an even greater extent. As an expert of wheat varieties he should have illustrated the different morphological characters, at least in the most critical cases, in order to make it even more obvious that certain varieties — in spite of their identical number of chromosome — differ in certain morphological and physiological characters. This would have explained it better why he renamed certain so far independent species as varieties (e.g. *T. durum*, *T. turgidum*, *T. polonicum*, etc.). These remarks are not, however, intended to reduce the importance of the paper which is considered, as a whole, to be of scientific value.

In the discussion the author gives a convincing evidence to the idea that the origin of wheat is not "monophyletic" as was generally thought so far. In agreement with the opinion of other wheat geneticists the author points out that the development of the present wheat species started at least in two lines. To prove this theory he takes the distribution, areas of overlapping of the individual species and the chronological order of their origin (which he traces back to some 10,000 years) into consideration apart from the palaeontological data. He suggests that *Triticum boeoticum* — occurring in Asia Minor even today — is one of the initial species of the "biphyletic" development. This species extended toward north and was transformed — possibly through mutation — into *Triticum monococcum*, with a chromosome number of $2n = 14$; it is — in the opinion of the author and others — one of the ancient homozygous (AA) diploid forms. This form crossed with *Aegilops speltoides* and produced the two grained wheat: *Triticum dicoccum*, a tetraploid form ($2n = 28$). Its further progenies would be the later tetraploid forms: *T. durum*, *T. turgidum*, *T. polonicum*, *T. abyssinicum*, etc. The author considers all of them as varieties — though tetraploids, whereas others consider them as independent species; it is not clear what are the physiological and morphological characters on the basis of which the author qualifies them as varieties. He has, however, a very important observation, namely, that these tetraploid forms did not develop into hexaploids as the other line did, but remained in a tetraploid stage up to the present day. *Aegilops squarrosa* — required for their further development — was missing.

The other line started from the Trans-Caucasian region. In the course of the discussion the author renders it probable that the original form was *T. urartu* from which developed — with the participation of *Aegilops speltoides* — the tetraploid *T. georgicum. T. carthlicum* originated, on the other hand, from *T. georgicum* and not from *T. dicoccum*. The final development of hexaploid wheats — *T. spelta, T. aestivum* ssp. *vulgare* — started also in the Trans-Caucasian region where *Aegilops squarrosa*, indispensable for the development of hexaploid wheats, occurs. Thus *T. georgicum* could not meet *T. dicoccum* species growing in Asia Minor in the neolithic age. These hexaploid wheat varieties contain 42 chromosomes and their origin is proved by artificial crossing too. It was in this way that *T. spelta* was produced by crossing *T. dicoccoides* with *Aegilops squarrosa*. In 1949 KIHARA gained *T. spelta* similarly by crossing *T. dicoccum* and *Ae. squarrosa*. Artificially produced amphiploids proved to be morphologically cytologically and genetically identical with the natural spelt. Some authors suppose, however, that the present *T. aestivum* species could have originated from *T. spelta* and *T. antiquorum* crossed. This is the widest spread wheat of today. However, the author's relevant reasoning is convincing, so his theory of a "biphyletic" development can be accepted.

The author discusses the conflicting opinions as well. To prove his statement he gives a table showing the two lines of development; here he illustrates the possible relations through which, and the historical eras when the individual wheat species developed. So the table informs us of *T. spelta* having originated in 500—2000 B. C. with the intervention of *Aegilops squarrosa*, and *T. turgidum* and *T. polonicum* being evolved only around 1000 A. D.

Another valuable part of the paper is the taxonomy of wheat varieties compiled by the author mainly on the basis of investigations made by Flaksberger, Lelley, Rajháthy, Mansfeld and himself. In his taxonomy — in agreement with the above authors — there are three types of wheat species: I. *Monococca*, (Flaksb.) (2n = 14), II. *Dicoccoidea* (Flaksb.) (2n = 28) and III. *Speltoidea* (Flaksb.) (2n = 42).

The individual species and varieties are found within these types. In his taxonomy the *Monococca* sub-order consists of 2 species and 3 convarieties; in the *Dicoccoidea* there are 4 species and 12 convarieties and in the *Speltoidea* 4 species and 8 convarieties; that is, 10 species and 23 varieties altogether.

As to the 3 main types in author's taxonomy, I consider Flaksberger's system better, since it determines the individual groups uniformly on the basis of their chromosome numbers, namely: 1. *Diploidea* (n = 7), 2. *Tetraploidea* (n = 14) and 3. *Hexaploidea* (n = 21); while in the author's present system the first two groups *(Monococca* and *Dicoccoidea)* are set up according to the number of grains, the third *(Speltoidea)*, on the other hand, differs from the other two by grains having awns.

Finally, the author establishes that wheat species had at least two places of origin: Asia Minor and Trans-Caucasia. The Asia Minor line attained — through the diploid *T. monococcum* — the tetraploid level in *T. dicoccum; T. turgidum, T. polonicum* and *T. durum* are supposed to be its progenies.

This line did not reach the hexaploid level. The initial species of the other — the Trans-Caucasian line was probably *T. urartu;* species that can be traced back to it are the tetraploid *T. georgicum*, then *T. carthlicum* and finally — through *Aegilops squarrosa* — *T. aestivocompactum*, which name — according to the author — only intends to show that evolution of the common wheat began with the ancient full-eared form and the present form of *T. aestivum* ssp. *vulgare* developed only later. The author points out, finally, that the hexaploid wheats are, in fact, the results of human culture, and this is the very line that gathered a world-wide economic importance.

My opinion about the above paper can be summed up by the following: it has been written with relevant and reliable scientific data and other authors' results have been taken into consideration, its conclusions are acceptable and — at the same time — it has brought order in the origin and taxonomy of wheat species. It would be desirable if the author made similar order in other agriculturally important plant groups too. It requires enormous work, circumspection, objective and literary knowledge, but the prospective result would compensate for all the efforts.

As to the references I only wish to note that the author should have mentioned works of several notable Hungarian authors, including more of his works too, to show the readers that he has been carrying on scientific work in this line for several decades. I consider the paper to be of high scientific value and recommend it to be published in its full extent.

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ARE THERE OTHER POSSIBILITIES FOR THE ORIGIN OF T. SPELTA OR T. AESTIVUM?

I have read dr. Gy. Mándy's new suggestions concerning the origin of the common wheat with great interest and wish to make some remarks on certain parts of the paper.

As to the origin of the subspecies *spelta* [ssp. *spelta* (L.) Thell., by some authors *Triticum spelta* L.] the author writes the following: "It is a question which wheat species was the progenitor of *spelta*. *T. dicoccum* or *vulgare* itself could not possibly be. A tetraploid Caucasian wheat species, *T. carthlicum* or perhaps *T. turanicum* may be supposed to have been the progenitor, but one of the North-Caucasian forms of *T. georgicum* might have been as well." Experiments carried out by McFadden—Sears (1946) and Kihara (1949) were a great help in detecting the origin of the subspecies *spelta;* they obtained *spelta* by crossing *T. dicoccoides* and *T. dicoccum* respectively with *Aegilops squarrosa* and amphiploidizing the hybrids. These plants were morphologically, cytologically and genetically identical with the subspecies *spelta*. Some authors (Schieman 1946, Gögköl 1939 etc.) consider Asia Minor to be the primary gene centre of the two species; from there they may have spread southward (to Egypt and Abyssynia) and northward (to the northern side of the Caucasus) with the great migration.

This does not — of course — exclude a different possible origin of *spelta*. *Spelta* found in Iran and described by Kuckuck in 1959 did not supposedly originate in the same way and at the same place as the subspecies *spelta* spread from the northern slope of the Caucasus to the Alps did, and it was not through migration from the west to the east that it appeared in Iran. The author too thinks the Iranian *spelta* to have originated from *T. turanicum* × *Aegilops squarrosa*, through an amphiploid mutation.

In a phylogenetic relation the question of *speltoid* is raised too. In the course of his mutation experiments Swaminathan (1963) obtained *speltoid* plants from *vulgare*. More or less frequently — depending on the weather — we also observed — like others (Lelley—Rajháthy 1955) — speltoid types in field- and experimental plots of *vulgare* which, though somewhat different from the subspecies *spelta* (less closed glumes and somewhat less fragile rachis, lower degree of fertility and vitality), may have played a role in the development of *spelta*. Accordingly, this subspecies is supposedly not of "monophyletic" origin but, like other hexaploid wheat species, mentioned by the author — developed in more than one way.

As to the evolution of *vulgare* the author thinks that only one of the three possible modes of origin suggested by Sears (1959) is probable, namely that "*vulgare* originated from the crossing and amphiploid mutation, of *T. carthlicum* × *Ae. squarrosa*". In my opinion the subspecies *vulgare* too might have developed in more than one way. Namely, in our experiments in the F_2 generation of *spelta* × T. *carthlicum*, besides sterile plants of *square-head* and *compactoid* ear-character, constant *vulgare*-type plants segregated as well, which in every respect (morphologically, genetically and cytologically) were equal to *vulgare* and produced fertile hybrids with it.

Since according to the general opinion *spelta* originated later than *vulgare*, the other mentioned way of origin might have enriched the range of forms in the subspecies *vulgare* already existing at that time. Perhaps it is just to its non-"monophyletic" origin that the extraordinary adaptability and range of forms of *vulgare* are due — apart from the D-genome of *Ae. squarrosa* and a conscious human activity.

The author's suggestion on the origin of *T. carthlicum* is reasonable. He thinks that "the progenitor of *T. carthlicum* should be found in its present area. It is obvious that it must have been a similarly tetraploid species, the more primitive character *T. georgicum* Dekapr. (= *T. palaecolchicum* Men.), from which *T. carthlicum* developed by mutation (the grains drop out of the earlets". Nevertheless, no convincing evidence of either this or the author's suggestion of *sphaerococcum*, *amplissifolium* and the Iranian *spelta* subspecies originating from *T. turanicum* is available.

Swaminathan (1963) obtained *sphaerococcoid* and *vavilovoid* mutants in addition to *speltoid* types with X-ray and ethyl-methane-sulphonate treatments. However, on the basis of experimental results obtained by Barabás (1959) and Scaraccia *et al.* (1961), he does not exclude the possibility of the subspecies *vavilovi* being an amphiploid progeny of a *vavilovoid* mutant (originated from *T. carthlicum)* × *Ae. squarrosa.*

Mándy mentions that it is not known whether "*T. urartu* originated from *T. boeoticum* through a parallel mutation (the same way as *T. monococcum* developed), or another wild *monococcum* was its progenitor". It is probable, however, that it developed from an earlier wild monococcum rather than from *T. boeoticum*. So, it is possible that this very species was the progenitor of *T. boeoticum* since — according to ZHUKOVSKY (1957) — it has a considerably more primitive habit.

Although the origin of it is *vulgare* which is discussed in the paper, I should like to mention the role of *T. ispahanicum* Heslot in the evolutionary system of wheat. According to our experimental results as well, this species is most closely related to *T. polonicum* (KIHARA *et al.* 1956), while its relation to *T. durum* and *T. dicoccum* is much less close. This fact also proves that from *T. dicoccum T. durum*, then from the latter *T. polonicum* and finally *T. ispahanicum* developed by mutation.

Mándy's reasonable explanation of the origin of *vulgare* — though lacking in experimental data — has given answer to many questions thus promoting our knowledge acquired so far concerning the origin of the common wheat.

To be successful in our breeding work we must by all means know the past of wheat which explains the wide range of its forms and its high adaptability. There is no doubt that the modern methods of breeding and genetics developed through a many-sided and thorough study on natural evolution may promote the efficiency of our breeding work.

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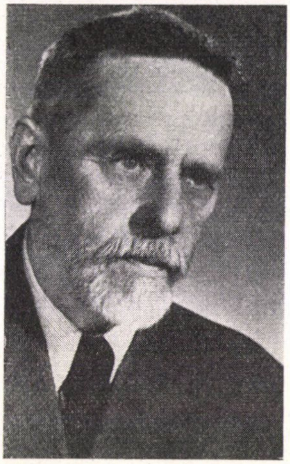
CHRONICA



ROBERT BALLENEGGER
1882—1969

It was on November 13, 1969, at the age of 87 that Robert Ballenegger Kossuth-prize winner professor of soil science and agrochemistry died. He was one of the most important and most progressive soil scientists in the first half of the century, active almost to the last days, who even over 80 took part in study trips and soil surveys and imparted his knowledge and skill to the following generation.

Robert Ballenegger was born on 11th November 1882 at Temesvár. His father was a Swiss language teacher settled in Hungary. His mother was German, his father French, so he spoke perfect Hungarian, French and German from his earliest childhood. As a student he learned English, Latin and Italian languages, then, after graduating, Russian language too.

He graduated in 1904 at the University of Budapest as a teacher of chemistry and physics and soon obtained a doctor's degree of chemistry too. Between 1904 and 1910 he worked as a chemist, and owing to his extensive knowledge of languages he excelled in making translations — especially from Hungarian to various foreign languages — already at the beginning of his scientific career.

In 1910 he was invited to work at the agrogeological department of the Institute of Geology in order to make the chemical research work of the section more efficient. Another aim was to utilize Ballenegger's language knowledge. The first world conference on agrogeology (soil science) was held in 1909 in Budapest and its proceedings had to be issued in various languages; further, relations made with the most important countries of that time had to be nursed by opening correspondence with them. Ballenegger was the best-fitted for performing this diffucult task beside leading the chemical section. In summer he generally made soil surveying in various parts of the country while in winter he processed partly his own research material, partly the data of his co-workers. He had, however, a third important task too, namely, being responsible for the foreign relations he often visited the countries of Europe and made a study tour even in the United States.

In 1919 Ballenegger sided with the Hungarian Soviet Republic, therefore he was dismissed later from the Institute of Geology. As he had been teaching soil science at the Horticultural School since 1918, he applied for and was given a post there as the teacher of soil science and chemistry.

Besides research work Ballenegger's most important object in life was to teach both in writing and speaking. Although he was low-voiced, a man of few words and never a great speaker, Ballenegger was a real teacher. The small number of students that up to the second world war always remained below 100 excellently suited his faculties. Nevertheless, owing to his previous political attitude he was not given an official teacher's commission, and although this scope of activity was that of a teacher, his title between 1922 and 1930 was "horticultural inspector". Besides, the then director of the school whose intention was to train the students to be brigade leaders, foremen, etc. fitted to occupy subordinate posts in large estates or offices was against Ballenegger and the other scientifically qualified progressive minded teachers who wanted to raise the educational level of the school.

In 1930 Mátyás Mohácsy who had just returned from his study tour made in the United States became the director of the school. During his long journeys abroad Mohácsy learned that a quantitative and qualitative improvement can be attained in horticultural production only through scientific research work, so he found a great helper in Ballenegger. The scientific level of the Horticultural School rose rapidly. Ballenegger was provided with a well equipped department and good co-workers. It was a highly productive phase of his life. From 1940 on, after he had retired, he published his profound knowledge and rich experiences in many scientific and popular papers.

After World War II Ballenegger was invited to be the professor of soil science at the newly established University of Agricultural Sciences. A new period opened before the 63-year-old professor. The department of soil science ceased to exist at the Technical University and its equipment was given over to Ballenegger. Although after the destruction of war, research work started but slowly on account of the limited number of instruments, chemicals, periodicals and room available, Ballenegger carried out enormous work in the course of four years, till 1949. Then the number of students suddenly amounted to more than 200 per course, Ballenegger's weak voice could not fill the room any more, so, at the age of 67 he finally retired.

For several more years he delivered lectures on soil science at the Eötvös Loránd University as a private docent. As the expert adviser of the Research Institute for Soil Science and Agrochemistry of the Hungarian Academy of Sciences he worked till the end of his life. He published many books and papers, became the president of the Society of Soil Science, and also president of the Committee of Soil Science, Sub-committee of Pedology and Methodological Committee of the Hungarian Academy of Sciences. In 1957 he was awarded the Kossuth-prize and in 1965 the University of Horticulture conferred a honorary doctors degree on him. At the age of 73 he organized the Congress on Soil Science of the Hungarian Academy of Sciences, and when 74 he was the leader of the Hungarian delegation at the World Congress on Soil Science in Paris. As one of the leaders, guiders and critics of soil research he performed a useful activity up to his death.

Ballenegger's scientific career developed at the Institute of Geology. By means of hydrochloric extraction of soils in 1912—13 he threw light upon the material movement taking place in the various genetic soil types. In 1913 he classified the Hungarian soil types. In 1914—15 he made investigations into the physical properties of plant nutrient reserves in the soil types; in 1917 published two papers on the chemical composition of the Hungarian soil types. At that time he dealt with orchard plantation in the Hungarian Great Plain from the point of view of soil research and with decay occurring under the moors. The results of these investigations were published in five foreign and seven Hungarian papers. His excellent work on soil science "Termőföldünk" edited in 1921 copes with most requirements even today.

He carried on soil surveying from 1910 first in county Békés, then in other parts of the Great Hungarian Plain; then successively in counties Baranya and Somogy and mainly around the Lake Balaton. During World War I he worked in Transylvania and the Southern Carpathian Mountains, in 1918 in the Tokay vine-growing district, then in the Great Hungarian Plain. His regional research work was published in 22 scientific papers.

In 1922 he began to teach at the Horticultural School which at that time was small and poorly equipped. At the beginning Ballenegger had little possibility to carry out research work. In the very first year he wrote his book "Bevezetés a növények életvegytanába" (Introduction to the biochemistry of plants) which served as a text-book for 22 years and had several subsequent editions. Owing to a lack of laboratories he decided to place the results of research carried out in soil science and agrochemistry at the disposal of Hungarian agricultural and horticultural producers. He started an extensive literary activity and published 37 papers in that period, in which he pointed out that agricultural and horticultural production cannot be improved by mere experiences descending from father to son. He presented the experiments that provided plant production with a new basis on one hand, and showed how yields could be increased and qualities improved in Hungary by means of agrochemistry, on the other. He dealt much with the agrochemical problems of ornamental plant production as well.

In 1930 he started research work in his well equipped department on the soil requirements, root development, water and nutrient supply of fruit trees. His excellent works often excited the international interest. In his basic research he investigated the nutrient requirement of the soil, the artificial soil mixtures of potted plants, the effect of salty ground waters in the Great Plain, soil physics, chemical composition of Hungarian apples, changes of nutrient content in the soil, the ash components of peach, the soil conditions of the Tihany peninsula, the agrochemistry of fruit tree fertilization, humus and many other minor problems. At the same time he continued to publish the most important results of research work carried out abroad. So from 1930 to his retirement 71, and after his retirement further 25 papers were published by him.

Ballenegger was a real scientist of soil science and agrochemistry who gave great assistance to aspirants, young researchers and the present leaders of soil research and education. He taught a scientific historical view, right evaluation of research work carried out all over the world, and application of exact methods in any problems of soil science. Soil researchers of today see their great teacher in Ballenegger.

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RECENSIONES

Some methodological achievements of the Hungarian hybrid maize breeding. Akadémiai Kiadó, Budapest, 1970. 385 pages, 152 tables, 24 diagrams, 14 photos.

The book gives a picture of the methodological researches of Hungarian maize breeders; it contains 33 papers divided into 7 main parts.

In the first part, which deals with the basic materials of breeding, Jánossy is the first to present the local variety collecting and maintaining work carried out by the National Agrobotanical Institute at Tápiószele. Hungarian local varieties contain a highly valuable basic material; e.g. yields of the most productive variety in the early (200) group exceed the average yield of the medium late (600) group. The paper includes an evaluation of lines originating from the local varieties. Kovács discusses in detail the problems arisen in connection with the choice and evaluation of basic material for breeding. He uses as models 60 plants of a Hungarian improved variety, most valuable from the point of view of starting lines to point out the selection possibilities by discussing the yield elements in detail, linking up in this way with the fifth part of the book where yield elements are discussed.

The second part, which deals with the development of inbred lines, begins with a study written by Bálint on degeneration concomitant of inbreeding, pointing out experimentally that inbreeding involves also an increase in the rate of undesired mutations. Kovács's paper on the development of new lines lays stress in its method on the per se evaluation of young lines by studying the yield components of lines. In his investigations Gyulavári aims at using the monoploid method to obtain excellent lines from a valuable basic material more quickly. For this purpose he produced a reliable early flowering marker line and elaborated for the breeding practice the useful methodics of selecting monoploids. He also performed experiments to increase the rate of monoploids.

The subject of the third part is the evaluation of inbred lines. In the first paper Gyulavári evaluates early testing and Stadler's gamete selection method emphasizing the aspect of practical breeding. He points out the value of early testing, as characters obtained in the S_2 generation were readily transmitted considering the average of the progeny. No doubt, there were essential value differences rendering the development of sublines necessary in the progeny as well, but selection, made possible by early testing, permits breaking down of valuable lines into sublines. The method of gamete selection has not yielded valuable results, however, the experiment was not laid on such wide bases as permitting to draw general conclusions concerning gamete selection. The paper written by Csetneki and Gyulavári testifies the importance of selecting testers, discussing in detail the test-crossing data of 26 and 15 lines with two and three single-cross testers, respectively. With earliness and tendency to grow suckers considered in addition to the yield, essential differences are found in the special combining ability, therefore lines cannot be discarded on the basis of bad results obtained with a single tester. When examining the special combining ability of lines Kovács uses line testers in his study, and starts experiments not only with these single-crosses thus obtained, but also with double-crosses obtained with these single-crosses as seed parents and one tester single-cross as pollen parent. The advantage of the method is that productivity of double-crosses is determined directly and not by prediction on one hand, and the productivity of mother single-crosses is simultaneously determined, on the other, which is very important not only from the point of view of seed production, but also because the best ones — e.g. Mv 530 — can be introduced in commercial production. In the last paper of the third part Kovács points out a considerable variability within the population of old lines, and refutes the complete homozygousness of even the oldest lines; but beyond this, by selecting the sublines he has attained a significant improvement of existing hybrids: three-way-crosses obtained from the synthetic of the best sub-lines and the old single-cross partner are highly valuable.

In the fourth part treating the subject of male sterility, Papp is the first to draw conclusions from a study on back-crossed series of 12 lines concerning the question of what are the characteristics by which the course of the development of male sterile analogue can be most readily assessed. When studying Texas-type male sterile and restorer basic materials used at Martonvásár, Csetneki found that both male-sterility and fertility restoration were reliable under various environmental conditions. He adds, however, that the restoring ability of partially restorer lines depends to a great extent on the crop year, though no detailed data in this respect are published. In his next paper Csetneki gives the 5 years' results of comparison of the productivity of 6 hybrids produced partly by removing tassels and partly in a male-sterile way, and points out that no difference in productivity can be found between hybrids obtained with the two methods of seed production: among the 39 comparisons only three reached a significant difference of 5 per cent. Oraby studied the effect of male-sterile cytoplasm on productivity and other characteristics of plants from the aspect of seed production. In micro-plot experiments — where pollination of male-sterile plots could not be imperfect either — Texas-type single-crosses were compared with their normal and restorer analogues: as compared to the normal sterile hybrids showed only a slight, while the restorer analogue a more considerable crop failure. The paper presents the combining ability of several lines too. In the next paper Oraby examines the combining ability of the Texas-type male-sterile form of a WF 9 line obtained with three different donors and of its Moldavian-type male-sterile analogue in six test crosses in order to obtain a picture of the effects of donors. Yields vary by crop years and testers, but the yield-increasing effect of the Moldavian-type male-sterility is significant. A comparison with the normal WF 9 line would be interesting. In his study illustrated with original microphotos, Oraby examines the division of pollen mother cells in male-sterile plants in order to determine the phase in which the degeneration phenomenon of male-sterility appears. The last paper of the part dealing with the question of male-sterility studies in male-sterile lines and their normal analogues the force required for pulling up a plant. Authors — as they write — had not known the method of measuring anchorage of plants in maize — since they are not specialists of maize breeding — and made a new instrument for this purpose. The instrument proved fit for use and with its aid the authors pointed out that the strength of the root system depends on the cytoplasm, as the male-sterile line had in most cases considerably stronger roots than its normal analogue.

The fifth part of the book deals with the yield components. In the first paper Kovács examines in detail the heterosis effect shown by the five major yield components and the yield resulting from them in the various crosses: these heterosis indices significantly differ from each other. He found that inter-crossing of single-crosses gave only a heterosis index below 100 (93.59), that is, on the average of the examined six cases double-crosses yielded 6.41 per cent less than the single-cross parents. This fact does not mean, however, the lower productivity of double-crosses in general, as productivity of excellent parent single-crosses exceeds not only the double-crosses but also the non-parent single-crosses. Herczegh evaluates the importance of seven different yield components from the point of view of yield and finds essential differences. He examines correlations between the components too. The very close ($r = 0.95$) correlation between ear length and grain size may be caused by the fact that the examined population consisted of lines and hybrids. The third paper of this part (written by Kovács, O'sváth and Kovács) examines the role played by the yield elements of the ear as active components in producing yield by means of path analysis. The path analysis investigates the role of 9 components as they develop in four steps the weight at harvest of the ear. Finally, when studying the uniformity of the yield elements Kovács and Kovács point out interesting differences between lines, single and double-crosses and varieties in the evenness of their ears. Since, however, second ears of plants were also put to examination, hybrids producing more second ears might have seemed less uniform.

Discussion of individual breeding objectives begins with a study by Herczegh on some questions of cold tolerance. Cold test data are summarized in an index obtained by germination percentage divided by the product of multiplication of time and temperature. On the ground of cold test data of 11 hybrids a negative correlation was found between cold tolerance and the length of the vegetative period, while in six lines the male-sterile form was less cold tolerant than the fertile form. The next paper concludes from the examination of 3 lines on a better cold tolerance of sterile forms, thus a different character of the cytoplasms of donors can be suspected. Dolinka elaborated an index determination method for the purpose of breeding for frit-fly resistance, which gives the resistance of the line or hybrid in a single statistically evaluable figure. The great differences found permit the expectation of new results in resistance breeding. On the basis of the index 5 degrees of resistance were determined. By a regrettable mistake in more than one places "degree of resistance" is written instead of "resistance index", and examples illustrating the determination of the index because of a disturbing misprint seem not to be precise. Namely on page 288 $Ff_1 = 0.1$ is instead of $Ff_1 = 0.2$ and this misprint is disturbing in the formula too. When studying the frit-fly resistance of some lines and their male-sterile analogues, by means of this index Oraby and Dolinka discovered essential differences between the lines and found the male-sterile forms more resistant. Csetneki and Barabás investigated the radio-sensitivity of lines and hybrids by comparing the fertile and male-sterile forms both at seedling and developed stage. Among doses tested in the four years experiment those of 4 and 8 Kr were applied and highly remarkable differences were found in radio-sensitivity. The series of papers discussing the individual breeding objectives is closed by Kovács's work, which — while indicating with its title a study on the qualitative improvement of maize — deals with the most important question of quality: the protein problem only. On the basis of protein differences in sublines selected from the parent line of a hybrid, the author improves the protein yield of the hybrid and considers the amino acid contents too. However, neither the per se examination nor any other test crossing are suitable to select the sublines; owing to a lack of correlation, testing must be carried out with the other parent of the hybrid.

The last part of the book which deals with biological researches begins with a study by Kovács on the nutrient movement between main shoots and tillers. The value of the paper consists of the precise examinations having been carried out at different phases of ontogeny and productive and sterile tillers studied separately. Gáspár presents his method elaborated for the determination of the biological value of maize protein: determination of salt soluble protein and non-protein nitrogens by means of gel filtration. In the last papers of the book Kovács discusses the effect of circumstances influencing the value of seed. Author reports significant differences not only in the subsequent year's yields of lines but also in yields of single-crosses produced as a reaction to different fertilizers applied to lines, and recommends the different fertilization of parents. He deals in a separate paper with the effect of this fertilization on resistance to wilt disease. Although significant differences in resistance between crosses produced from differently fertilized lines are reported on the basis of one year experiments, no logical correlations can be concluded on from the results; it would have been interesting to learn whether fertilization had any effect on resistance in the lines themselves. His paper describing the effects of germination percentage and initial growth vigour testifies that even those seeds which show a 72 per cent germination with increased seed number and thinning for initial growth vigour do not result in reduced yields. He studies in a separate paper the quantities and proportions of total nucleic acid and adenine in the pollen and seed of lines and hybrids; on the ground of results obtained so far the author considers this proportion to be the measure of vitality. The series of papers is completed by a study on the indole acetic acid content of differently fertilized lines and their single-crosses.

The nicely got-up book is lacking in a list of misprints, although some of them might be confusing. So, for example, on page 19 LSD is to be read instead of GD, on page 44 $\left(\frac{1}{2}\right)^n$ instead of $\frac{1}{2}$ n, in the figure on page 113 III tester instead of I tester, in the table on page 140 Mv 602 instead of Mv 1, etc. In some places the text is superfluously lengthy or tables are too detailed, but this does not alter the fact that the book gives a clear picture of recent work carried out in the most varied parts of maize breeding in Hungary. The book discloses that Hungarian hybrid maize breeding which has produced valuable hybrids by the well-known classical breeding methods, contributes with its methodological research work to the international knowledge of hybrid maize breeding as well.

L. Berzsenyi-Janosits

Népi kultúra — Népi társadalom (Folkways — people's society). A Magyar Tudományos Akadémia Néprajzi Kutató Csoportjának Évkönyve, II—III. (Yearbook of the Folklorist Group of the Hungarian Academy of Sciences II—III.) Akadémiai Kiadó, Budapest, 1969.

Members of the Folklorist Group of the Hungarian Academy of Sciences reported this time on the most important results of their research work in 15 studies. The collection of papers deals primarily with the material and intellectual folklore of Hungary. The way it treats the subject is of very high level and of comparative character. Great part of the illustrations consists of original photos. The collection of papers is completed by a short summary written in German.

From an agricultural view-point the studies on Hungarian livestock breeding and peasant farming are of international importance.

Kovács in his study: "Pásztortűzhelyek Erdélyben 1900 körül" (Fireplaces of herdsmen in Transylvania around 1900) discusses the fireplaces and firing equipments of the Transylvanian herdsmen, first of all those of shepherds. Beside describing the various forms of fireplaces he deals with the structure and arrangement of boiler stands, cauldrons and boilers too.

Szabadfalvi in his paper: "A magyar állattenyésztés tipológiai és terminológiai problémáihoz" (Contribution to the typological and terminological problems of Hungarian livestock breeding) deals with the etymological questions of wild and open air stock-farming, but touches upon the typical problems of the Hungarian geographical regions too.

Kósa's study: "Találmányok a paraszti gazdaságban" (Inventions in peasant farms) is especially important from an agricultural view-point. Namely in Hungary, in spite of the great changes of the last decades (new plant varieties and species of animals, extended professional knowledge, increased arable area, higher market possibilities, etc.) peasant farming has remained on the whole traditional. The clever inventions, a part of which (corn planter, potato planter, drill-hoe, potato lifter, etc.) is dealt with in present paper, are due to the natural way of thinking characteristic of the Hungarian peasant.

Paládi-Kovács: "Az abara. Egy szénatároló építmény a magyar parasztok gazdálkodásában" ("Abara", a special hay barn in Hungarian peasant farming). The author's paper supplies a great want, since little has been known so far about the meadow and hay farming of Hungarian peasants. Author throws light on the spread, function and cultural historical background of the "abara", a less known hay storing building used earlier as granary too. (The word "abara" originates from the Ukrainian word "oborih".)

In his study: "A sertéshús tartósítása a paraszti háztartásban" (Pork preservation in the peasant households) Kisbán E. calls attention to an interesting problem. Author describes the popular methods of chopping and preserving meat, making lard, basting, making stuffing and sour soups.

Papers, dealing with problems which do not bear direct relations to agriculture, are also significant:

Gunda: "Az ember és az *Echeneis naucrates* kapcsolata" (Relationship between man and *Echeneis naucrates*). Historical relations of remora fishing in various parts of the earth; Filep: "Kétbeltelkes mezőváros (Ónod) XVII. századi látképi ábrázolása" [17 th century panoramic illustration of a double-grange country town (Ónod)]. Folkloristic and settlement historical data of characteristic settlements on the northern border of the Hungarian Great Plain; Manga: "Egy magyarországi szlovák falu" (A Slovakian village in Hungary). Processing of material and intellectual folkloristic data on the reformation and changes occurred in the village Vanyarc, Nógrád county, in the 18 th century; Kovács: "A XX. században rögzített magyar népmeseszövegek XIX. századi nyomtatott forrásai I. Arany László magyar népmesegyűjteménye" (19 th century printed sources of Hungarian folktale texts fixed in the 20 th century I. Hungarian folktale collection by László Arany); Nagy: "A magyar Noé-történetek nemzetközi kapcsolatai és műfaji kérdései" (International relations and literary genre of the Hungarian Noah stories); Szemerkényi: "A proverbiumok logikai-szemantikai összehasonlító vizsgálatához" (Comparative logical-semantical study of proverbs); Küllős: "A magyar népköltészet lírai dalműfajai és a kéziratos énekköltészet" (Hungarian lyrical folk-song forms and the hand-written lyrical poetry); Hoppál: "Gyerekijesztők — I." (Frightening of children); Jávor: "Asszonyfarsang Mátraalmáson" (Women's carnival at Mátraalmás); Diószegi: "A honfoglaló magyarság hitvilágának történeti rétegei. A világfa" (Historical strata of the religious beliefs of the first Hungarian settlers. The world's tree). On the basis of a very thorough comparative study author supposes that the Hungarian concept of world's tree, which can be found even today in the beliefs, tales and decorative art of the Hungarian people and proved to be an ethnical characteristic, has its root in the Uralian cultural basis of the Hungarian people.

Not only folklorists, linguists and folksong and folktale collectors, but also Hungarian and foreign researchers, experts and teachers of plant growing, livestock breeding, botany and zoology can make use of these papers.

L. Gy. Szabó

Studies about humus
Transaction of the International Symposium "Humus et Planta IV". Prague, September 1967. 316.

The work published by the Central Research Institute of Plant Production of the Agricultural and Food Research Centre, Prague (editors: B. Novák, and V. Rypácek) sums up the lectures delivered at a conference held in 1967 in Prague with the participation of many internationally acknowledged representatives of the humus research.

The nearly 100 participants delivered 60 lectures at the conference. The publication contains the text of the lectures delivered in part in English, in part in Russian languages in the form of papers, completed with literary references. The preface was written by V. Kás.

The conference was the result of a co-operation maintained in this field of science — with an ever increasing international interest — by the Czechoslovakian Academy of Sciences, the Czechoslovakian Botanical Society, the Polish Academy of Sciences and the Polish Botanical Society. The symposium is the continuation of a series of conferences; the first was held in Posnan, in 1957 the material of which was published in 1960 in the Acta Agrobiologica IX; lectures of the second symposium organized in 1961 in Prague and Brno were published in 1962 by the CSAV Publishing House in the form of a book, under the title "Studies about humus". The third symposium — in 1967 — was held again in Prague in the organization of the earlier mentioned institutions assisted by Polish researchers, further by the Central Plant Production Research Institute of Prague, the Microbiological Institute of the CSAV, the High School of Agriculture in Prague, the J. E. Purkyne University of Brno and the Brno High School of Agriculture.

The increasing interest and differentiating subjects made it necessary to organize the 1967 conference in the following four sections:

1) Processes of humus formation (introductory lecture by H. M. Hurst, the Harley Botanical Laboratories, The University, Liverpool).

2) The chemical composition and physical properties of humus substances (introductory lecture by W. Flaig, Institut der Biochemie des Bodens, Braunschweig-Völkenrode).

3) The influence of humus on the soil qualities (introductory lecture by M. M. Kononova, Pochvenny Institut imeni Dokuchayeva, Moscow).

4) The influence of humus substances on the physiological expression and nutrition of plants. (Introductory lecture by S. Guminski, Institut Botaniczny Universitetu Wroclawskiego im. Boleslawa Bieruta, Wroclaw).

The work of the four sections was coordinated by the plenary meeting with Silvestr Prat academician, honorary president of the symposium in the chair.

At the session of the section "A" which dealt with the formation of humus substances, 11 lectures were delivered. They included the substrates and the microbiological chemistry of humus formation, and the characterization of the role of soil and other factors influencing the humus formation.

The lecture delivered by H. M. Hurst, chairman of the session, under the title "Processes occurring during the formation of humic substances" discussed thoroughly the role played by various organic compound groups of plant origin in the formation of humus, with special stress laid on the importance of aromatic structured, phenolicnatured humus precursors which are resistant to microbiological decomposition, on the role of lignin, flavonoids as well as of microbial pigments of quinnoid nature. Among the processes of humus formation he emphasized the co-polymerization of phenolic units from a variety of sources.

In the lectures delivered at the session of the section mainly model experiments were given account of, in which in vitro transformation of various humus substrates in the course of the microbial metabolism was examined in the presence of different environmental factors.

A lecture was delivered on the structural relationship between humic-like black polymer produced by the Azotobacter chroococcum and humic polymer originating from lignin (M. Robert-Gero et al.). Lecture delivered by V. Tichy: "Decomposition of lignocellulose by wood-destroying fungi as a model of humus formation", as well as papers by L. Schánel: "Red pigment formation and humic acid synthesis by white-rot fungi", and G. Müller et al.: "Some aspects of biologically formed humic substances" — belong to a similar scope of subjects. B. Novák selected his subject from the enzymology of humus formation: "The effect of free oxidations and oxidative phosphorylations on humification". In other works humus formations are studied in the natural environment: the soil: H. E. Freytag: "Glucose decomposition and new formed humic substances", D. Wójcik-Wojtkowiak: "The influence of

$NaN^{15}O_3$ and $(N^{15}H_4)_2CO_3$ on the humification of straw in the soil and on the nitrogen utilization from the humified material by plants", E. N. Mishustin—G. N. Mrysha: "Fractions of humus substances of soil and their decomposition by microorganisms".

The interaction of inorganic colloids and humus formation was examined by Z. Filip: "The development of microorganisms and the production of humic substances in sand cultures with different bentonite contents".

The paper by S. Prát on the special conditions of humus formation: "Humus formation in saline waters" has to be separately mentioned.

At the meetings of section "B" 12 lectures were delivered. The introductory lecture of W. Flaig, chairman of the section had the title "Chemical composition and physical properties of humic substances", in which the most important processes and initial materials of humic substance formation, the origin of humic nitrogen and the distribution of oxygen atoms in the different functional groups of humic acids were surveyed. The lecture dealt with the possible chromophore groups of humic acids on the basis of visible and ultra-violet absorption spectra, and presented the results of the most recent examinations concerning the size, molecular weight and ultra-microscopic structure of humic acid macro-molecules.

Within the scope of the lectures of section "B" several lectures dealt with the up-to-date fractioning methods of humic acids. So G. Ferrari et al. and F. Pospisil delivered lectures on a similar subject, on the humic acid-analytical application of the method of gel-filtration; B. G. Murzakov introduced the separation of fulvic acids by column-chromatography. K. Kumada and O. Sato lectured on the spectrophotometric characterization of "P"-type humic acids isolated from different horizons of various soil types. D. S. Orlov gave account of investigations into the relationship between the chemical structure and optical properties of humus in his lecture: "Some problems about the structure and identification of humus substances". V. Lochman discussed the changes on the optical and chemical properties of humic and fulvic acids under the influence of ammonia gas saturation during compost-making. Two lectures were delivered on the interaction of humic acids and metal ions. D. Kleinhempel lectured on the dynamics of organic bound iron in the soil, while D. S. Orlov et al. reported on the polarographic examination of the interaction of humic acids and heavy metal microelements. The paper of S. A. Gordienko dealt also with the characteristics of metal ion-humic acid complexes in relation to brown coal and peat humic acids. Finally, this section included B. Válek's paper, which compared montmorillonite clay-metal and humus with respect to the effect exerted on the maximum capillar moisture capacity.

The highest number of lectures, 23, were delivered in section "C". The close correlations of the different questions prevented the strict separation of subjects, so papers presented in this group are connected in many respects with subjects of sections "A" and "B". The introductory lecture delivered by the leader of the section M. M. Kononova surveys the entire scope of problems of humus-soil relation. S. S. Dragunov dealt with some questions of humic acid formation. The effect of external factors on humification was discussed in two papers: the paper by S. Franklová—B. Novák deals with the influence of temperature, while that of V. Cizek with the effect of oxygen level on humification. Humus dynamic response to intensive manuring was treated by S. Sotáková, then J. Szegi explained the role of C and N sources in the microbiological decomposition of Na-humate. J. Nováková analysed the quantitative effect of certain clay-minerals on the decomposition of glucose. The paper of J. Pokorná-Kozová deals with the effect of humus on the activity of cellulose decomposing microorganisms. The problems of soil respiration, humus substances and fertility are raised in the papers of J. Damaska, E. Knotková and R. Apfelhaler. In this section the subjects of humus composition and characterization were treated by S. S. Dragunov et al., N. G. Zyrin et al. and W. Rawald. Humus forms and dynamics of different soil types were discussed in lectures delivered by K. Mráz, J. Pelisek, B. Grunda and I. Zimont. Two lectures by M. Niklewski et al. on the fertilizing effect of peat preparations as well as S. Krystanov's paper: "Some changes of soil organic matter influenced by management" represent a separate scope of subject. Soil aggregate forming property of organic matters, a subject that had excited much interest several years ago, was treated only in the lectures of A. Kullman and E. Paul.

At the session of section "C" two lectures of special interest were also delivered, by D. McGrath on the soil pigments and by T. V. Drozdova on the geochemical role of humic acids.

The most "practical" section of the conference was section "D", although lectures on humus-plant relations presented valuable results of basic research.

The 13 lectures delivered at the session of section "D" were introduced by the comprehensive lecture of S. Guminski: The effect of humus compounds on some physiological processes and plant nutrition.

The lecture of P. A. Vlasyuk: "The importance of organic substances for plant nutrition" was also of a summarizing character.

A part of the lectures dealt with the direct plant physiological effect of humic substances, while another part with such indirect actions in the course of which humic substances influence the uptake of plant nutrients.

D. Vaughan examined the effect of humic acid on the invertase activity of beet root tissues.

L. A. Christeva et a . gave account of the manifold influence of soil humus on plant metabolism and seed quality. M. Valla's lecture dealt with the response given by the plant to humic acids of different origin. Z. Sladky's paper analyses the growth regulating effect of humus substances on isolated roots. On the basis of experiments carried out with tomato plants W. Rochus pointed out that the so-called "Humate effect is not a general effect but a very specific one and is related to the specific humic acid fraction". V. Tichy and H. Nechutová reported on very interesting new results concerning the effect of various humic acid fractions on the energy metabolism of plants. V. Rypácek gave account of factors influencing the activity of humic acid preparations, storage and the role of the storing time. H. Söchtig and W. Loginov lectured on the effect of humus substances on the nitrogen utilization of plants. Lectures by F. Lemaire and E. Wenglikowska-Niedzwiecka covered some questions of humus and phosphorus and potassium uptake, respectively. M. Niklewski spoke of the fertilizing effect of peat preparations.

To sum up what have been said, the publication reveals the fact that though in the last decades practical agronomy repeatedly revised the importance and role of the organic matter content of the soil, the desire of scientific cognition — in this field, where there is a lot to discover — continues to stimulate the researchers, which is proved by the subject material of the 1967 symposium of "Studies about Humus" in Prague. We think that the publication "Humus et Planta IV." has enriched the literature of soil science with a valuable work.

L. GÁSPÁR

G. UBRIZSY, and A. GIMESI: *A vegyszeres gyomirtás gyakorlata* (Practice of chemical weed control). Mezőgazdasági Kiadó, Budapest, 1969, 310.

The handbook, which supplies a long felt need in the field of agricultural chemization, is of basic importance in the agrotechnical practice. The general part deals with the biological and chemical elements of chemical weed control by presenting the biochemical part processes of the action mechanism and selectivity of herbicides. Herbicide combinations are summarized in tables with the aim of widening the range of herbicides. In addition to herbicides generally used in practice, those tested in the last years and recommended for commercial utilization are discussed in detail, with their commercial name, indicating the active agent and chemical composition and giving instructions for use. Contact and systemic herbicides are presented in tables too, with a brief survey on the most important chemical, biological, human toxicological, residue-biological, agrotechnical etc. characters. The reader is given a detailed information on the technological requirements of spraying as well as on what is to be done in the case of intoxications occurring when plant protectives, more precisely herbicides, are applied.

The practical part describes the herbicides recommended for the various soil types according to up-to-date viewpoints, grouping them by cultivated plants from the aspect of the agrotechnical practice, with a detailed analysis on the after-effects. The book is especially particular about the chemical methods of dodder control in alfalfa, the possibilities of after-seeding in sand soils without ploughing, by using herbicides, the agrotechnical advantages of regulator application, the possibilities of weed control in irrigation canals, the technology of weed control on pastures and other practical applications aimed at attaining higher yields. Relative quantities of herbicide residues as well as the different sensitivity of weeds to herbicides are also included in tables. General instructions on the chemical weed control of the most important plants are also given in tabular form too. This modern handbook which provides the practical agrotechnical applications with a theoretical foundation, gives the less frequent special terms as lexically determined, and is completed with references of the most recent literature.

By providing a theoretical basis for chemization in agriculture, the handbook promotes the wider application of herbicides in Hungary in order to increase our internationally favourable position in this respect.

B. I. Pozsár

ERRATA

The correct legends of the figures in the report published on pp. 385—392 of Vol. XIX of Acta Agronomica Acad. Sci. Hung. are as follows:

Fig. 3. Flower primordium of Petroselinum hortense at the plicatio stage of carpels. A highly meristematic zone (m) in the wall of the young pistil. (Obj. 10×, oc. 5×)

Fig. 4. In fully developed Petroselinum hortense flowers at the basal zone of petals and stamina joined with the ovary wall an active meristematic zone still can be found. (Obj. 10×, oc. 5×)

Fig. 5. Ovary part of Pastinaca sativa pistil with the meristematic zone (m). (Obj. 20×, oc. 5×)

Fig. 6. Longitudinal section of fully developed Foeniculum vulgare flower. (Obj. 10×, oc. 5×)

Fig. 7. Part of a Helianthus annuus young inflorescence with flower primordia. (Obj. 20×, oc. 5×)

Fig. 8. Flower primordium of Helianthus annuus after the appearance of petal, stamen and pistil primordia. In the receptacle part the meristematic zone begins to show up. (Obj. 20×, oc. 5×)

Fig. 9. Part of a Helianthus annuus young inflorescence with flower primordia. In the centre of the receptacle a meristematic zone (m) is left. (Obj. 10×, oc. 5×)

Fig. 10. Fully developed flower of Helianthus annuus with a meristematic zone (m) still active. (Obj. 10×, oc. 5×)

Fig. 11. Flower primordium of Calendula officinalis with a meristematic zone (m) in the receptacle part (Obj. 20×, oc. 5×)

Fig. 12. Fully developed flowers of Calendula officinalis with meristematic zones still seen Obj. 5×, oc. 5×)

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VARIA

FORUM

CHRONICA

RECENSIONES

"Probleme agricole"

is a periodical of agricultural science and practice, published in Rumania as an organ of the Higher Council of Agriculture and destined to the specialists in agriculture with higher studies.

The review publishes works concerning the problems of the development of the agricultural production (original researches, papers drawn up on the basis of experiments and of the scientific literature of speciality, achievements of the foremost agricultural units) in the following fields: economy and organization of the production, utilization of the land fund, plant melioration, agrotechnics, phytotechnics, plant protection. The original works are accompanied by Russian, English, and French summaries.

The review contains also the chronicles of certain important scientific events and manifestations from Rumania and from abroad, and the reviews of works published in different countries.

EUPHYTICA

Netherlands Journal of Plant Breeding

Vol. 19 (1970) (about 550 pp.) contains 70 articles. Some are:

Selection for combining ability in pyrethrum, Epistasis for crown disease in the oil palm, cytoplasmic male sterility in petunia, Cytogenetical studies in wheat, Electron-microscopy on anther tissue and pollen of male sterile and fertile wheat, Basic information for the use of primary trisomics in genetic and breeding research work, Promotion of pistillate flowering in *Cucurbita* by 2-chloroethylphosphonic acid, Crossability values whithin the Slash-Caribbean *Pinus* species complex, Yield variation in the early productive years in trials with cacao, Propagation of celery, Tissue culture of the oil palm, Incompatibility in the cross *Rhododendron impeditum* × *R. williamsianum*, Genome relationship in *Solanum* hybrids, Time and site of the S-gene action, Self-incompatibility in *Ribes*, Sterility in some *Ipomoea*-species, Interspecific crosses in *Linum*.

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Vol. 30 (1970) contains over 100 research articles, among others on: Divergence in relation to geographic origin in a world collection of linseed; Genotype × environment interaction in grain sorghum; Fractional diallel crosses in linseed; Monosomic analysis in bread wheat; Stability of strains derived from disruptive selection in *Brassica;* Stability of some high-yielding varieties of rice; Genetics of evolutionary change; Inheritance of protein content in *Pennisetum typhoides;* Genetic analysis of yield, rust resistance etc., in bread wheat; Genetic analysis of some exotic × Indian crosses in sorghum; Effect of incorporation on Opaque-2 gene on yield and yield components in maize composites; Cytogenetic studies of *Oryza officinals* complex; Development of hybrid wheat etc., etc.

Published three times a year in volumes of about 450 pages. Vol. 31 appears in 1971. Subscription: Rs. 50 U.S. dollars 8 per year inclusive of postage; A few copies of Vol. 17 (2), containing the proceedings on an International Symposium on "GENETICS AND PLANT BREEDING IN SOUTH ASIA" organised in 1958 in cooperation with UNESCO (Price Rs. 25 or dollars 6) are still available. A special number containing the proceedings of the Symposium on 'Impact of MENDELISM ON AGRICULTURE, BIOLOGY AND MEDICINE' held in February 1965, has been published as Vol. 26 (A) Price Rs. 30.—, or $7.—, postage and packing extra. Another special number of the Journal (28A) incorporates the proceedings of a National Symposium of "ACCELERATING GENETIC IMPROVEMENT OF INDIA's PLANT RESOURCES" Price Rs. 30.— or $7.— (Postage and packing extra).

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CORRESPONDENCE and orders should be addressed to the individual publication, c/o Agricultural Institute of Canada, Suite 907, 151 Slater Street, Ottawa 4, Canada.

Methods in Plant Pathology with Special Reference to Breeding for Disease Resistance

edited by Z. KIRÁLY contributors to this volume:

Z. KLEMENT, J. VÖRÖS, Z. KIRÁLY, F. SOLYMOSI

In English — Approx. 410 pages — 17 × 25 cm — Cloth

The book deals with plant pathological methods used in laboratory and field experiments. In addition, the authors exemplify the most important experimental procedures on types of plant diseases. The information is discussed from the point of view of the life cycle of pathogens, the cultural methods of microorganisms, the methods of artificial inoculation in greenhouse or field experiments, the detection of physiologic races of plant pathogens and the sources of disease resistance. Most of the methods have been used in practice and applied to research in the laboratories and experimental stations of the Research Institute for Plant Protection, Budapest.

Protein Growth by Plant Breeding

edited by A. BÁLINT

In English — Approx. 180 pages — 17 × 25 cm — Cloth

Increasing demand of world population for more meat, milk, eggs, and plant products of higher protein content, make it necessary that the protein content of the more important crops should be increased and the ratio of the fundamental amino acids, like lysine, tryptophan and methionine in proteins, improved.

In Hungary, research in this line was started as early as 1954 at the Department of Plant Improvement, University of Agricultural Sciences, Gödöllő.

The present volume reports on the results and methods elaborated during the past fifteen years in Hungary.

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РЕЗЮМЕ

АНАТОМИЧЕСКОЕ, УЛЬТРАСТРУКТУРНОЕ И ФИЗИОЛОГИЧЕСКОЕ ИЗУЧЕНИЕ ОДНОГОДИЧНОЙ ФОТОСИНТЕЗИРУЮЩЕЙ КОРЫ У *Euonytus europaeus* L.

Й. СУЙКО—ЛАСЗА, Г. ХОРВАТ, Й. НАДЬ, Г. ФЕКЕТЕ, А. ФАЛУДИ—ДАНИЕЛЬ

На основе исследований с помощью светового микроскопа, описана анатомия тканей, содержащих хлоропласты в одногодичной ростковой оси у *Euonytus europaeus.* Используя световой и электронный микроскопы установлено, что эпидермис функционирует как феллоген, и создает феллодерму с двумя рядами клеток, которая может сохраняться в течение 4—5 лет. Первичная кора одногодичного побега может быть разделена на 4 слоя. По нашим исследованиям 4 внешних клеточных ряда первичной коры можно принять за зону самой активной фотосинтетической деятельности. В феллодерме, а также в меристеме первичной коры хлоропласты могут развиваться из пропластов. Зеленые пластиды, находящиеся в паренхимных клетках сердцевины содержат несколько гранул. Фотосинтетическая активность коры была подтверждена инкорпорацией CO_2^{14}. Количество фотосинтетически связанного CO_2 пересчитано на содержание хлорофилла, и было одинаковым по величине и у коры, и у листа. Сравнение между летним и осенним включениями CO_2 показывает, что путь фотосинтетически включенного CO_2 летом является другим, чем осенью.

АНАТОМИЯ ВЕГЕТАТИВНЫХ ОРГАНОВ, НАКАПЛИВАЮЩИХ ЗАПАСНЫЕ ВЕЩЕСТВА

I. КОРНИ

Г. С. ПАЛИВАЛ, А. К. КАВАТХЕКАР

Изучилась анатомия специализированных корней (видоизмененных для накопления запасных веществ) следующих растений: (1) *Brassica rapa* (2) *Discorea bulbifera* (3) *Ipomoea batatas* (4) *Manihot esculenta* (5) *Raphanus sativus.* Выявлено, что они (I) имеют хорошо развитый перидерм, который оформляется раньше в онтогенезе (когда органы только начинают накапливать запасные вещества); (II) обладают главным образом паренхимными тканями, которые являются самыми подходящими для накопления; (III) показывают относительно слабое развитие сосудистых элементов; (IV) составлены из клеток, богатых эргастическими веществами в форме друзид и рафидов; и в конечном счете (V) показывают отсутствие межклеточных пространств в паренхиме. Эти корни хотя и выполняют идентичную роль, и имеют одинаковую почвенную схему, имеют переменную организацию, которая зависит от того, является ли растение однодольным или двудольным. Расположение сосудистых тканей, латексных клеток, слизистых протоков, степень образования перидерма, типы и частота крахмальных зерен и эргастических веществ, и т. д. очевидно также определяются генетическим строением вида.

ГЕТЕРОГЕННОСТЬ МИОЗИНА И СПЕКТРОФЛЮОРОМЕТРИЧЕСКОЕ ИЗУЧЕНИЕ ЕГО ХРОМАТОГРАФИЧЕСКИХ ФРАКЦИЙ

Ш. ФАЗЕКАШ, В. СЕКЕШИ-ХЕРМАН, И. КАША, И. ХОРНЯК

Работа посвящена гетерогенности миозина и изучению структур его хроматографически разделенных фракций, на основе их возбужденного и флюоресцирующего спектров. Методом хроматографии на DEAE целлюлозной колонке миозин разделялся на 4 белковых и 2—3 липидных фракции, у которых изучалась активность Ca—ATP-азы, а также AMP-дезаминазы, и связь холинестеразы с миозином. Установлено, что все 4 фракции белков обладают активностью ATP-азы, и только фракции I, I/a и IV имели активность холинестеразы. Из всех фракций только II и III могут считаться чистым миозином потому, что лишь они имеют активность ATP-азы. Перед хроматографией миозина обработка энзимом не применялась. Активность энзимов в фракциях липида не обнаружена. Спектры поглощения изученных фракций белков и липидов, так же как и частное E_{280}/E_{260}, вычисленное из их экстинкций, 280 и 260 mm соответственно были разными. Сопоставлены и обсуждены возбужденный и флюоресцирующий спектры полученных фракций белков. Они доказывают соответствующие составные фракции. Возбужденный и флюоресцирующий спектры фракций липидов имеют низкую интенсивность, возможно обусловленную белковыми остатками потому, что свежеполученные липиды почти не имеют абсорбции, их спектр плоский и нехарактерный, тогда как максимум и в возбужденном и флюоресцирующем спектрах переокисленного липида смещался в направлении более длинных волн.

ПЕРВИЧНЫЕ АМИНАЦИОННЫЕ МЕХАНИЗМЫ В НЕПОВРЕЖДЕННЫХ ЛИСТЬЯХ ФАСОЛИ PINTO ПРИ УВЕЛИЧЕНИИ УРОВНЯ ГЛИЦИНА

ДЬ. ОРОШ

Отделенные листья растений фасоли Pinto, выращенных на бедной азотом почве, были инфильтрированы раствором KNO_3, потом помещены в темное место. Изменения в содержании свободного цистеина, лизина, аспарагиновой кислоты + аспарагина, глутаминовой кислоты + глутамина, глицина, аланина, тирозина, триптофана, фенилаланина + лейцина + изолейцина, метионина и пролина в образцах определялись методом бумажной хроматографии. В начальной фазе индуктивного синтеза нитратредуктазного энзима наблюдалось общее увеличение аминокислотного уровня. Особенно достоверное увеличение проявилось в уровне глицина, аланина и глутаминовой кислоты. Между четвертым и шестым часами наблюдалось общее понижение аминокислотного уровня, по всей вероятности благодаря новому метаболическому равновесию, вызванному увеличением уровня экзогенного нитрата. Уровень свободной глутаминовой кислоты последовательно сохранил свой увеличивающийся характер. Полученные данные подтверждают мысль, по которой роль α-кетоглутарата и щавелевого ацетата не является исключительной, но их первичная аминация вероятна. В то же время первичная аминация может быть демонстрирована и через другие составные части, как напр. пировиноградат и ацетил—КоА. Механизм первичной аминации в листьях отличается от аминации в корнях. Изменения уровней метионина и тирозина можно считать характерными с точки зрения индукции, и нельзя считать — особенно в случае метионина — за продукт первичного аминационного механизма.

ОПЫТЫ СО СРОКАМИ ПОСЕВА КУКУРУЗЫ

И. И'ШО

В работе обсуждаются результаты опытов по срокам посева, проведенных с среднераннеспелым гибридом Мв 40 (ФАО 340) и среднепозднеспелым гибридом Мв 1 (ФАО 600) на глинистой луговой почве, с 1958 по 1969 гг. Посевы по пятидневкам не дали кривой, которая отклонялась бы к раннему посеву (15 апреля). По многолетним средним на делянках, где растения были посеяны позже (в мае), урожай среднепозднеспелых гибридов понизился сильнее, по сравнению с ранними сроками (5 мая), чем у среднераннеспелых гибридов (15 мая). Данные средних многолетних экспериментов показывают, что растения, посеянные месяцем раньше, созревали на 14—15 дней раньше.

ИЗУЧЕНИЕ АБНОРМАЛЬНОГО РОСТА РАСТЕНИЙ

Т. М. ВАРГЕЗЕ, Р. Р. ШАРМА

I. Анатомия опухолей, вызванных насекомыми на вегетативных частьях ***Prosopis spicigera*** **L.**

Заражение насекомыми листовой пластинки и главного черешка у ***Prosopis spicigera*** L. бывает в ранних фазах развития органов, которые являются нежными в это время. Галлы на листьях формируются благодаря гипертрофии и гиперплазии мезофильной ткани и медуллярных клеток. Формирование полостей в пластинчатых галлах является шизогенным. Галлы главного черешка развиваются благодаря активности пробкового камбия одновременно с образованием лизигенной полости. Образование пробкового камбия в этом случае рассматривается как находящееся в зависимости от продукции некоторых гормонов, выделяемых ввиду повреждения центральных клеток. Образование галлов является полезным только для насекомого, а не для растения-хозяина. По всей вероятности использование подходящих инсектицидов будет надежным путем контроля этих опухолей.

ВЛИЯНИЕ ВРЕМЕНИ И ГЛУБИНЫ ВНЕСЕНИЯ АЗОТА НА РОСТ И УРОЖАЙ РИСА

НГУЕН ВАН УЕН

Потребность растения риса в азоте имеет продолжительный характер. Глубокое расположение азота, кроме того, что предотвращает потерю азота из почвы, насыщенной водой по механизму **Pearsall-Mitsui**, также удовлетворяет потребность растения риса в азоте в более поздний период роста. Урожай увеличился на 20—25% по сравнению с методом неглубокого внесения удобрения.

ИЗМЕНЕНИЕ ПОГЛОЩЕНИЯ Mn КРАСНЫМ КЛЕВЕРОМ ПОД ДЕЙСТВИЕМ ИЗВЕСТКОВАНИЯ

Д. ДЬЕРИ, Е. ЧЕХ, И. КЕРЕСТЕШ

На псевдоглинистой лесной почве в полевых опытах и в сосудах изучалось влияние известкования на содержание заменяемого и активного Mn, а также влияние известкования на содержание Mn в красном клевере *(Trifolium pratense)*, в зависимости от величины урожая сена. На основе опытов установлено, что показатель pH почвы тесно связан с содержанием активного Mn в почве, и это зависит также от величины дозы извести. Между содержанием Mn в красном клевере и величиной урожая сена найдена связь, которую можно выразить уравнением третьей степени, что обозначает: и много и мало Mn является неблагоприятным с точки зрения урожая сена. Чтобы получить оптимальный урожай, необходимо наличие оптимального содержания Mn в растении и оптимального содержания активного Mn в почве. Для красного клевера известкование с использованием малой дозы оказалось более благоприятным, чем с использованием большой дозы. Действие известкования можно достоверно проследить путем изучения содержания активного Mn в почве.

ИЗУЧЕНИЕ ВЛИЯНИЯ МИНЕРАЛЬНОГО УДОБРЕНИЯ НА ПИВОВАРЕННОЕ КАЧЕСТВО ЯЧМЕНЯ НА ОСНОВЕ КОМПЛЕКСНОГО ПОКАЗАТЕЛЯ ПИВОВАРЕННОГО КАЧЕСТВА

Э. ПОЛЛХАМЕР

По сравнению с необработанным контролем пивоваренное качество озимого и ярового ячменя сильно ухудшилось вследствие применения азотной подкормки. Дозы К в значительной мере улучшили пивоваренное качество, уравновешенные дозы NPK по сравнению с дозами N улучшили пивоваренное качество, но не могли вполне уравновесить ухудшающее влияние доз N. Комплексные показатели пивоваренных качеств ячменя даже в случае минимальных изменений качественных компонентов сигнализируют о значительных различиях в качестве при обработках минеральными удобрениями. Значит, эти показатели пригодны и для выявления качественных изменений, вызванных разными обработками минеральными удобрениями.

ЭФФЕКТИВНОСТЬ ГАММА-ОБЛУЧЕНИЯ ЯЧМЕНЯ НА РАЗНЫХ СТАДИЯХ РАЗВИТИЯ

Й. ШУТКА

На гамма-поле в Гёделе облучался сорт ярового ячменя MFB—104 на разных стадиях развития (кущения, выход в трубку, мейоз, эмбриогенез). В год облучения (M_1 поколение) уменьшились высота растений, озерненность и вес зерна, в то время как кустистость — увеличилась. В период мейоза растения были наиболее чувствительными к радиации, тогда как облученные на стадии эмбриогенеза они не изменялись в M_1 поколении и даже в M_2 могли наблюдаться только незначительные отклонения. В M_2 поколении растений, облученных дозой 1944 R на стадии кущения, частота появления мутантов составила 2,61 процента. Поколение M_3 оценивалось на основании хлорофильного теста. С увеличением дозы облучения изменяется частота мутаций. Сравнение мутабильности по фазам развития показывает, что наивысшая частота мутаций вызвана облучением во время мейоза и эмбриогенеза. Гамма-облучение растений на стадии кущения вызывает менее заметные хлорофильные мутации, однако когда была определена частота мутирования, значение последней оказалось близким к темпам появления мутаций при обработке в других фазах развития. Частота появления мутантов в 7,17 процента, полученная при облучении растений в фазу эмбриогенеза, является фактически завышенной, так как мутанты, возникшие в фазу многоклеточных эмбрионов, не могли быть отличимыми при примененном методе от других, возникших в одноклеточных эмбрионах. Облучение в разных фазах развития изменяет также и спектр хлорофильных мутаций, хотя точных зависимостей не установлено.

ВЛИЯНИЕ ФАКТОРОВ ПРОДУКТИВНОСТИ НА УРОЖАЙ ЗЕРНА, А ТАКЖЕ НА ЭЛЕМЕНТЫ СТРУКТУРЫ УРОЖАЯ СОРТОВ ПШЕНИЦЫ В ПОЛИФАКТОРИАЛЬНЫХ ЭКСПЕРИМЕНТАХ

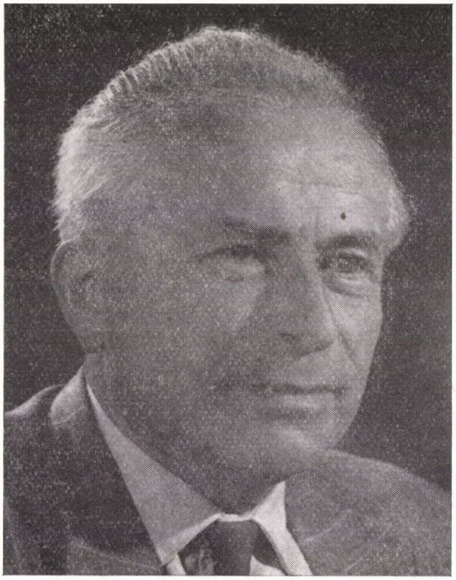
А. КОЛТАИ

В полифакториальных экспериментах, проводившихся в течение трех последовательных лет, изучались факторы, определяющие урожай пшеницы, а также их взаимоотношения. Эксперименты проводились при фракционных повторениях; в 81 главной делянке, расположенных в 9 блоках изучались три варианта обработки земли, глубины заделки семян, густоты стояния и времени посева, с каждым из трех изучаемых сортов в то время как внутри 81 главной делянки на 729 подделянках (расположенных по схеме расщепленных делянок) сравнивались 9 комбинаций, состоящих из трех разных доз и времени внесения азотного удобрения. В работе описываются условия и методика серий экспериментов, и даются простые и бифакториальные анализы основных данных об урожае зерна, компактности колоса, продуктивности колоса и абсолютном весе семян, а также достоверность результатов экспериментов. На основании трехлетних средних видно, что изученные факторы влияли на урожай в следующей последовательности: азотное удобрение, сорт, время посева, обработка почвы, глубина заделки семян, густота стояния и время внесения азота.

НАСЛЕДУЕМОСТЬ СКОРОСПЕЛОСТИ, А ТАКЖЕ ВЫСОТЫ РАСТЕНИЙ ГОРНОГО ДЖУТА ПРИ ДИАЛЛЕЛЬНОМ СКРЕЩИВАНИИ, ВКЛЮЧАВШЕМ 12 СОРТОВ

М. А. РАХМАН, А. М. ЭУНУС

Используя данные F_1 изучалась наследуемость скороспелости и высоты растений у *Corchorus olitorius* при диаллельном скрещивании, включавшем 12 сортов. По скороспелости сорта Ц. Г., 0—5, Desimasua, 0—753, Chinese *olitorius* и Р—26 показали наличие в большинстве случаев рецессивных генов, в то время, как сорта: О—632, О—6Е, Wild *olitorius*-Assam и *olitorius*-Coembator имели доминантные гены. По высоте растений сорта: О—632, О—6Е, Wild *olitorius*-Assam, *olitorius*-Coembator, и дикий джут Chittagong содержали больше доминантных генов, а Ц. Г., О—753, О—5, Desimasua и Р—26 имели больше рецессивных генов. В общем наблюдалось, что скороспелость и высота растений контролируется и доминантными, и рецессивными генами. В то время, как доминантные и рецессивные гены одинаково контролировали высоту растений, в наследовании скороспелости доминантные гены играли более заметную роль, чем рецессивные. Установлено, что 5 доминантных эффективных факторов контролируют скороспелость, в то время как 18 и 21 доминантных факторов включались в регулирование высоты растений. Трансгрессивное расщепление по высоте растений оказалось равным 9, где дикий джут был насыщающим родителем, и по скороспелости — 2, 3, 6 и 8, где насыщающими родителями были Ц. Г., О—753, Chinese *olitorius* и Р—26. Наследуемость по скороспелости была равна 53% в диаллельном скрещивании с 12 сортами, и 66% с 9 сортами, а по высоте растений она была равна 21% в диаллельном скрещивании с 12 сортами и 35% с 8 сортами.



A. Frey-Wyssling

REDACTORES
ACTORVM · AGRONOMICORVM
ACADEMIAE · SCIENTIARVM · HVNGARICAE

PROFESSOREM

ADALBERTVM · FREY-WYSSLING

DE · PROTOPLASMATVM · HERBARVM · VLTRASTRVCTVRA
INVESTIGANDA · QVAM · OPTIME · MERITVM

SEPTVAGENARIVM

MAXIMO · CVM · HONORE

SALVTANT

This paper is offered to Professor Adalbert Frey-Wyssling on his 70th birthday with great respect by

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ANATOMICAL, ULTRASTRUCTURAL AND PHYSIOLOGICAL STUDIES ON ONE-YEAR OLD EUONYMUS EUROPAEUS BARK DISPLAYING PHOTOSYNTHETIC ACTIVITY

By

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The present paper describes the light microscopic anatomy of tissues containing chloroplast in the one-year old shoot axis of *Euonymus europaeus*. In light- and electron microscopic studies the epidermis was found to function as a phellogen producing a two cell-row phelloderm which may survive for even four or five years. In the primary cortex of a one-year old shoot four layers can be differentiated. Our investigations suggest that the external four cell rows of the primary cortex can be considered the most active photosynthetic zone. In the phelloderm, and in the dividing cells of the primary cortex respectively, the chloroplasts may develop from proplasts. Green plastids found in the parenchyma cells of the pith contain some grana. The photosynthetic activity of the bark was shown by incorporated $^{14}CO_2$. The amount of photosynthetically bound CO_2 related to the chlorophyll content is of the same order of magnitude both in the bark and the leaf. A comparison of the CO_2 incorporated in summer and autumn respectively, shows that the summer products of photosynthetical incorporated CO_2 differ from its autumn products.

Introduction

It has been known for a long time that the external parenchymatic tissues of lignifying shoot axes are green as they contain chloroplasts. (Relevant literary review by SZUJKÓ-LACZA—FEKETE—FALUDI-DÁNIEL 1970.) In the case of some trees the seasonal changes of the chloroplasts in the axes have also been studied by a light microscope (ALEXANDROV—SAVCHENKO 1950). As to their activity, however, there had only been hypotheses until SCHAEDLE—IANNACCONE—FOOTE (1968) pointed out that they are able to carry out the Hill-reaction, therefore they are photochemically active.

In the framework of the IBP—PP section the authors have been making observations for several years in various species (*Fraxinus ornus*, *Quercus pubescens* etc.) taking some ecological relations of the metabolic functions of certain tissues in the lignifying shoot axes in consideration. During their work they performed light microscopic studies on all the tissues of the shoot axes (phelloderm, primary cortex, medullary ray, pith) that contained green plastids, assessed the approximate distribution of the chloroplasts, determined the chlorophyll content of each tissue zone, and in certain species measured the light transmission in the phellom. The results of the investigations were published in a paper (SZUJKÓ-LACZA – FEKETE – FALUDI-DÁNIEL 1970).

Further observations showed the shoot axis of *Euonymus europaeus* especially rich in chloroplasts and containing a great number of green chloroplasts even in the pith. (Beside its conspicuously rich chloroplast content this species differs from those examined earlier in that its medullary rays extend as far as the phloem fibers blocking the stele, and enter the primary cortex only sporadically.) *Euonymus* was considered the most suitable plant for providing information about the organization and ultrastructure of the chloroplasts in the different tissue zones as well as – with the aid of $^{14}CO_2$ incorporated – on photosynthetic activity.

The present study is an attempt at approaching the above problem on the basis of light- and electron microscopic observations, chlorophyll content determination and $^{14}CO_2$ incorporation.

Material and Method

For the purposes of light microscope studies cross-, tangential- and radial longitudinal sections were made of freshly collected one-year old shoot axes of *Euonymus europaeus* each season. For the purpose of comparison and in order to study the evolution of the different tissue zones, in addition to one-year old shoot axes, two-, three-, four- and five-year old shoots were examined as well.

In the electron microscopic examinations samples taken from fully developed leaves and one- and two-year old shoot axes in the summer, autumn and winter periods were used. The electron microscopic results are based on the samples taken in July. The material was fixed in $KMnO_4$ and embedded in durcupan. Uranylacetate and lead citrate were used as contrast materials. The electron micrographs were made by an electron microscope type KEM-I (GDR).

For the purpose of determining the photosynthetic activity of the chloroplasts found in the bark* and leaves of *Euonymus* as well as of *Fraxinus ornus* and *Quercus pubescens* used for comparison, the incorporation of $^{14}CO_2$ was studied. Assimilation took place in an atmosphere containing $^{14}CO_2$, with artificial illumination (10.000 lux) and in the dark (0 lux) respectively. The atmosphere had a CO_2 content of 0.25 percent and a specific activity of 0.4 mC/m mol. Before the one-hour assimilation the atmosphere was equilibrated for 30 minutes in darkness in order to ensure a uniform distribution of the released $^{14}CO_2$ in the system. After the assimilation leaf and bark fractions were smeared with 96 percent alcohol, the low molecular weight components were extracted with an alcohol series of 96, 70, 50 and 20 per cent and dried at room temperature. Radioactivity in the known quantities of the residue (which contained the high molecular weight substances) and the alcohol soluble fraction was measured with a GM-tube of 10 mg/cm^2 window thickness (of 13 per cent potence), and the results were calculated for nmol CO_2/g fresh weight. In the photometric determination of the chlorophyll components in the leaves an acetonic (cf. ARNON 1949) while of those in the bark an etheric solution was used (ZSCHEILE–COMAR 1941).

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* In physiological studies the term bark is used to mean both the cortex and phelloderm together.

Results

The epidermis cells of the one-year old lignifying shoot axes of *Euonymus europaeus* are covered by a thick transparent cuticle. The epidermal cells are cone-shaped (in cross section), and have stomata with subsidiary cells between them. The epidermal cells maintaining or regaining their meristematic character may divide either by anticlinal or by periclinal walls. In the former case they follow the growth of the stele, while in the latter case they function monopleurically and produce exclusively phellodermal cells inwardly (Fig. 5). After a gradual transformation the one- or two-rowed phellodermal cells become permanent. Permanent phellodermal cells are characterized by a low cytoplasm content and large vacuoles. Phelloderm formation can be observed as early as in the 2—3 month-old lateral shoots, and the two-cell-row phelloderm, together with the epidermis, can be found even in 4—5-year-old shoots. The epidermal cells that function as a phellogen have enormous nuclei, the cytoplasm is

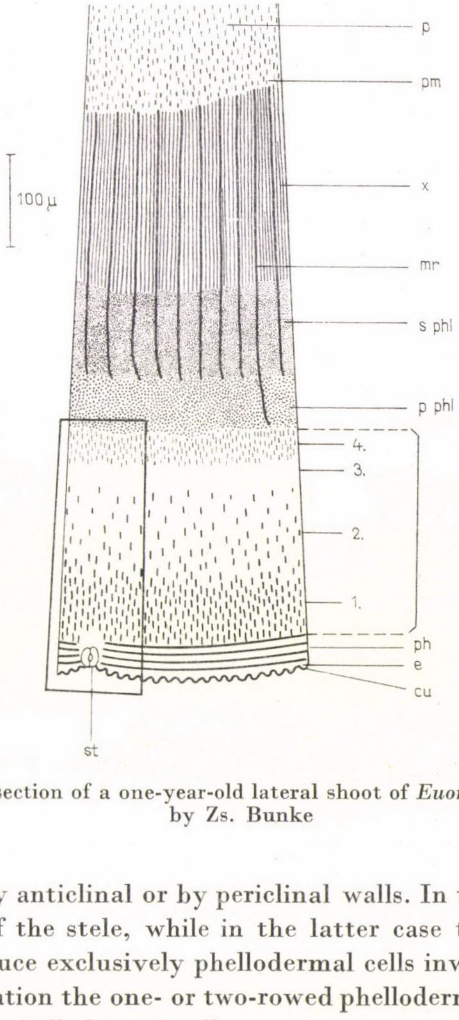

Fig. 1. Schematic cross section of a one-year-old lateral shoot of *Euonymus europaeus.* Drawn by Zs. Bunke

extremely rich in organels (ER, M) (Fig. 7). The young phellodermal cell differentiated from it is less electron dense than the epidermis (Fig. 5), the giant nucleus with the nucleole and the cytoplasm rich in ER are well definable in it

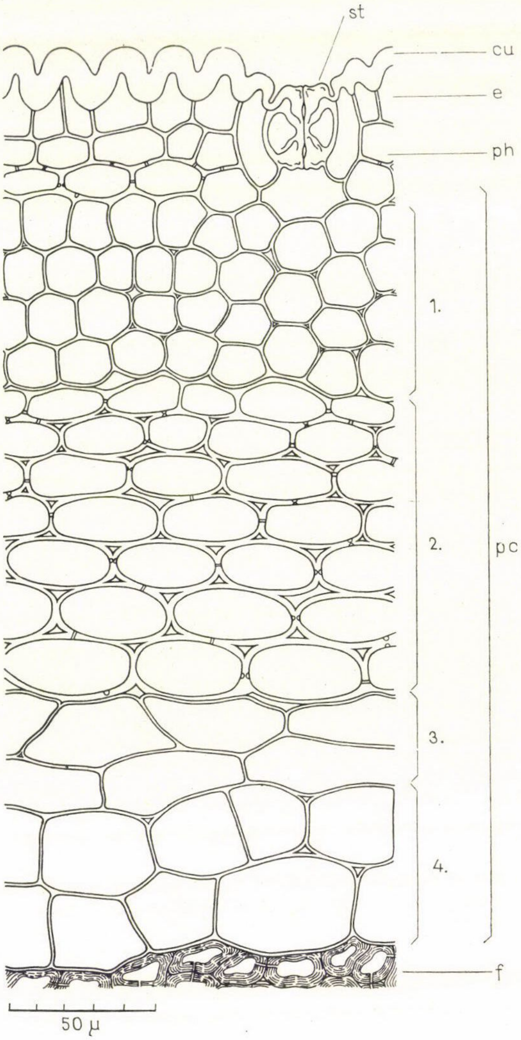

Fig. 2. Anatomy of *Euonymus europaeus* epidermis, phelloderm and primary cortex. Drawn by Zs. Bunke

(Fig. 8). The decidedly meristematic character of the phellogen and the young phellodermal cells — in which they differ from the permanent epidermal cells — proves that it is not a multicell-row epidermis that covers the shoot, as stated by HOLLENDONNER (1907), and there is no cylinder of collenchyma under the epidermis as suggested by McNair (1930). The phellogen function of the epidermis is independent of the cork cambium under the cork wings, and develops earlier, in contradiction to Hollendonner's statement.

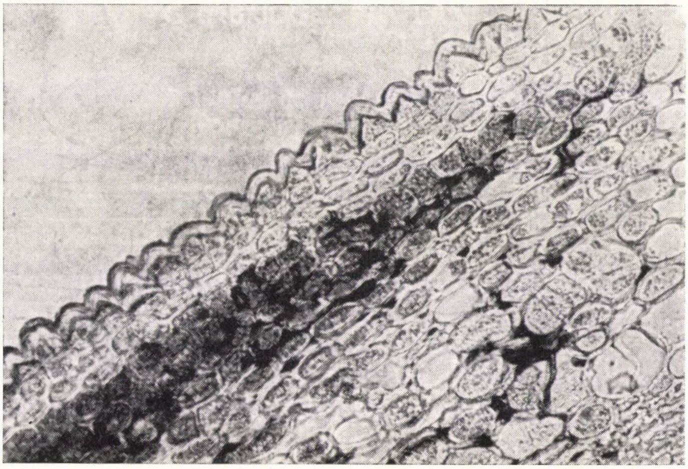

Fig. 3. Cross section of an *Euonymus europaeus* shoot axis, from the epidermis to the phloem fiber. Magnified: 420×

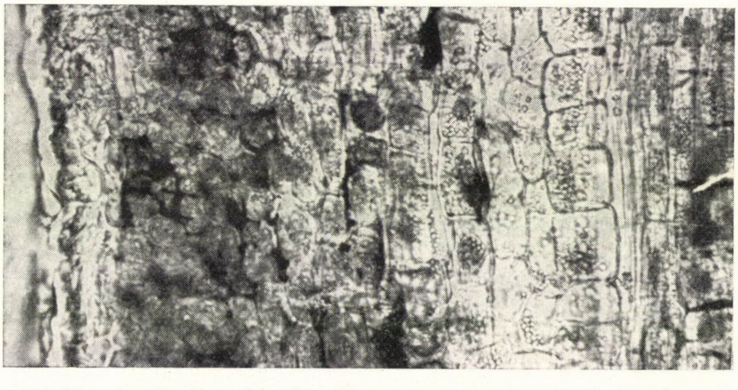

Fig. 4. Tangential longitudinal section of an *Euonymus europaeus* shoot axis from the epidermis to the phloem fiber. Magnified: 420×

In the plasm lining along the walls of the developed phellodermal cells a few chloroplasts developed from the proplasts can be found (Fig. 9). Differentiation of the proplast starts soon after the phelloderm has developed and the cell is still rich in cytoplasm (Fig. 8).

The primary cortex between the phelloderm and the stele consist of cells of different shape and chloroplast content. According to the arrangement of the cells the primary cortex can be divided into several layers (Figs 3–4).

Fig. 5. Epidermis and external zone of primary cortex, cross section. EM 3000 × Symbols: *c* = chloroplast, *cl* = chloroplast lamella, *cu* = cuticle, *cw* = cell wall, *e* = epidermal cell, *ER* = endoplasmic reticulum, *g* = granum, *i* = intercellular space, *n* = nucleus, *no* = nucleolus, *p* = proplast, *ph* = phellodermal cell, *s* = starch, *v* = vacuole

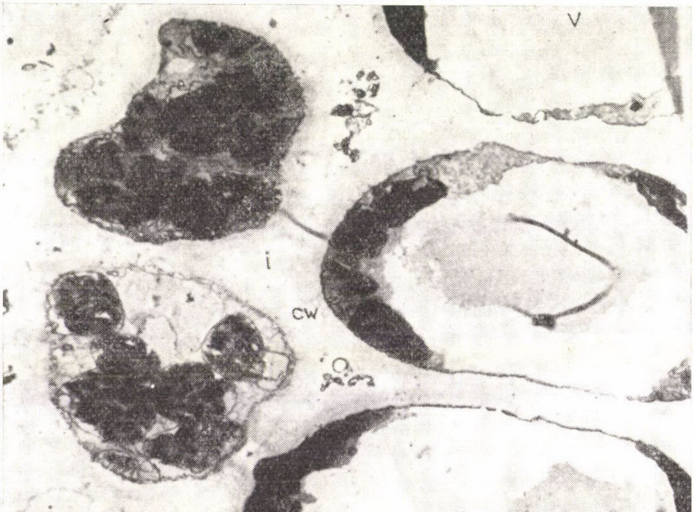

Fig. 6. External zone of primary cortex, cross section. EM 3000 ×

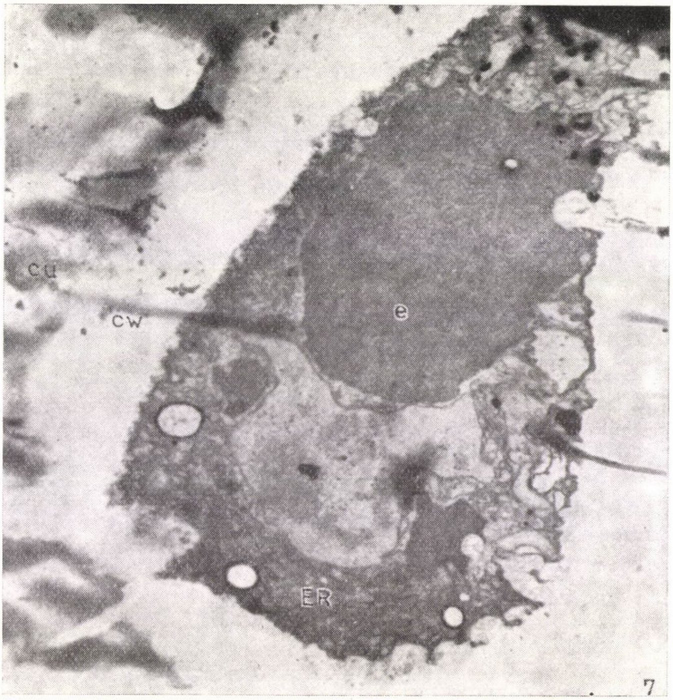

Fig. 7. Epidermal cell functioning as phellogen. EM 9000 ×

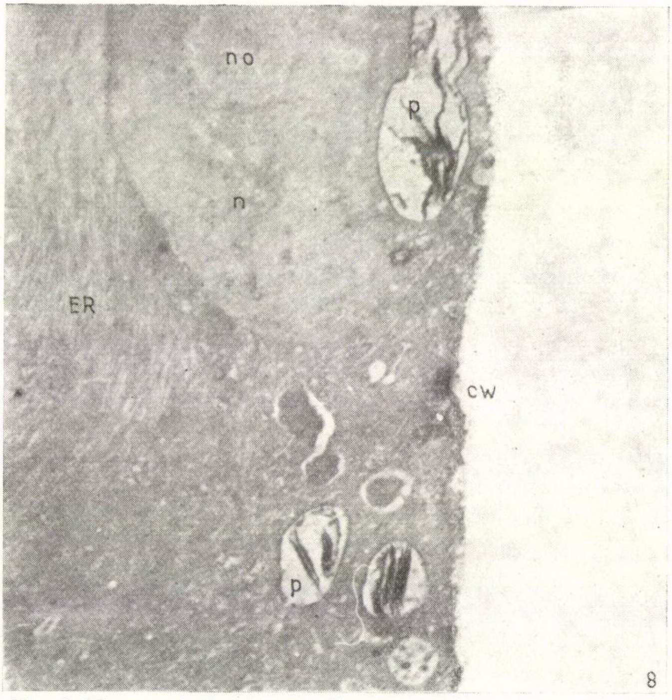

Fig. 8. Young phellodermal cell with proplastids. EM 15000 ×

Under the phelloderm there can be found a 60 μ thick intensely green layer consisting of four cell rows. (Data refer to lateral shoot axes of 1400 μ radius.) In this layer of the primary cortex (Fig. 2, layer 1) typical parenchyma cells are found with intercellular spaces here and there. The cells contain many chloroplasts. The parenchyma cells of this layer — as they follow the growth of the stele — divide at random — first of all by radial walls (Figs 5 and 6); the adjacent cells may therefore be different in size and age. The young, recently developed chlorenchyma cells are rich in cytoplasm and the numerous chloroplasts in them are — regarding their ultrastructure, size and shape — similar to those contained in *Euonymus* leaves. The grana of the chloroplasts are conspicuously thick (Fig. 10). The chlorenchyma cells could not be observed by the electron microscope in their actual phase of division, it is therefore uncertain, whether it is then that their chloroplasts divide. Nevertheless, it has been observed that in the young chlorenchyma cells proplasts occur in great numbers beside the developed chloroplasts, it is therefore supposed that in newly formed cells the proplasts may develop into chloroplasts (Fig. 11). When the chlorenchyma cells have become permanent they have got large vacuoles and the cytoplasm with the chloroplasts retreats to the cell wall which, at the

Fig. 9. Young and developed phellodermal cells. EM 3000 ×

same time involves the structural modification of the chloroplasts as well. The chloroplasts elongate in the direction of the cell wall, their lamellae become, more or less parallel with the cell wall.

In the primary cortex a 100 μ thick, 6—7 cell row layer follows the first layer in the direction of the stele (Fig. 2, layer 2). In the second layer the cells are tangentially highly elongated, and the occurrence of cells dividing by the radial walls is less frequent. The cell walls are covered with bordered pits, and the thin cytoplasm lining contains less chloroplasts. Here too, the chloroplasts are of granal structure and contain a conspicuously high amount of starch (Fig. 12). When advancing adaxially we get to the third layer which consists of two cell rows (Fig. 2). The cells have the shape of a tangentially elongated trapezoid, the cell walls are thin. This layer very rarely contains chloroplasts.

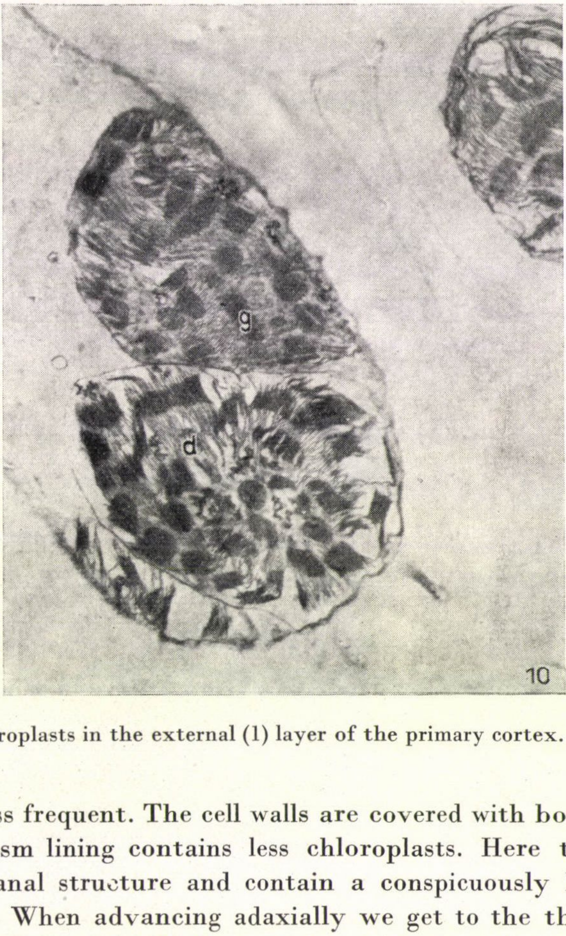

Fig. 10. Chloroplasts in the external (1) layer of the primary cortex. EM 9000 ×

The fourth layer adjacent to the stele contains two rows of extremely large parenchyma cells in which few chloroplasts and a rich starch content can be found. At the end of the vegetative period the second and fourth layers of the primary cortex contain much starch, while the first layer contains less starch; the third layer is free of starch. In 4—5-year-old lignifying shoot axes no increase in the number of cell rows in the primary cortex has been found compared to one-year old shoot axes. In older shoots cells in the first layer too elongate gradually, in a tangential direction. Later the layers cannot be clearly defined.

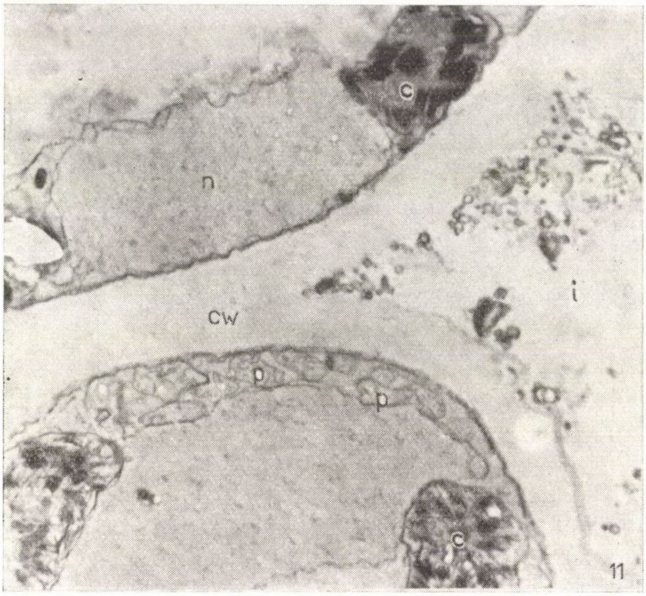

Fig. 11. Young chlorenchyma cells with proplastids. EM 6000 ×

Fig. 12. Developed chlorenchyma cell with cytoplasm along the cell wall and chloroplasts filled with starch. EM 4500 ×

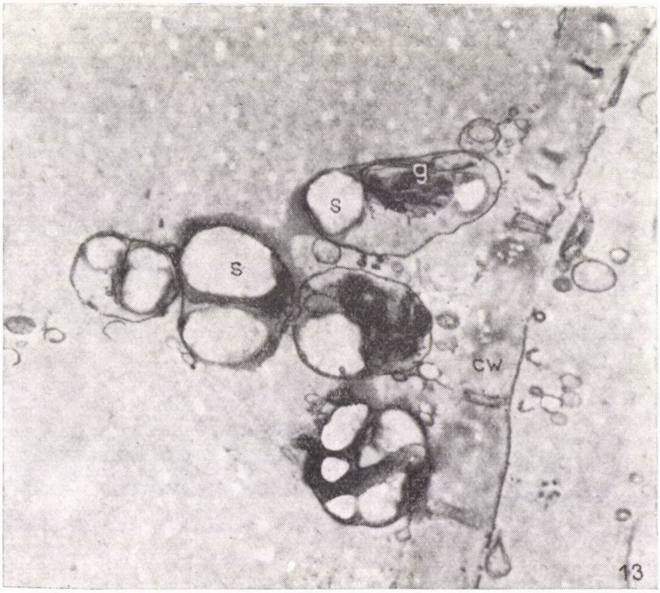

Fig. 13. Chloroplasts of pith with grana and starch. EM 6000 ×

Fig. 14. Chloroplast from Chloroan *Euonymus europaeus* leaf. EM 15000 ×

In the primary cortex collenchymatic cell groups can be found at four places. Collenchyma and cork wings have been dealt with in detail by v. Höhnel (1878) and Hollendonner (1907).

Since it is the tissue zones containing chloroplasts that have been primarily studied, only the cells of the medullary ray from the stele are dealt with here. The stele of the species was described by Metcalf—Chalk (1965) and Greguss (1969). The one-cell-row wide and many-cell-row high medullary ray cells run from the phloem fiber ring to the external layer of the pith that is, to the perimedullary zone. The medullary ray cells are brick shaped with bordered pits on the cell walls. They contain a considerable amount of green plastids, and from autumn on are rich in starch as well.

The parenchyma cells composing the pith also contain green plastids. The external layer of the pith, the perimedullary zone consists of isodiametrical or slightly elongated cells with relatively small diameters. Toward the centre of the pith the cells gradually grow in size. The electron microscopic examination of the pale green plastids of the pith reveals that they considerably differ from chloroplasts occurring in the leaf and primary cortex. They are only two thirds the size of the leaf chloroplasts and contain but a few lamellae, one or two grana and a great amount of starch (Fig. 13).

As the chloroplasts of the bark have a similar structure to those of the leaf, they are supposed to be able to perform the same functions. After a quantitative demonstration of the chlorophyll content in the bark and leaf (Table 2), the incorporation of $^{14}CO_2$ was studied with the method described in "Materials and Methods" in order to prove the photosynthetic activity of the chloroplasts. With a view to comparison, in addition to *Euonymus europaeus*, *Fraxinus ornus* and *Quercus pubescens* were also tested (Table 1).

Table 1

Comparison of photosynthetic activity in bark- and leaf chloroplasts

Material		nmol CO_2/g fresh weight		Photosynthetically bound CO_2 nmol CO_2/μmol chl
		dark	light	
Euonymus	leaf	62	17,700	9,020
	bark	186	3,010	5,100
Quercus	leaf	76	11,900	3,280
	bark	114	1,170	4,820
Fraxinus	leaf	192	34,700	12,800
	bark	77	1,700	15,100

Table 1 shows CO_2 incorporation in the leaf and bark; data are means of July and October. In light the extent of CO_2 incorporation is higher by 2 orders in the leaf, and by 1 order in the bark than the dark fixation. The amount of photosynthetically bound CO_2 referred to the chlorophyll content is of the same order in both the leaf and bark. In the case of *Euonymus europaeus* CO_2 as related to chlorophyll content was bound to a lower extent in the bark than in the leaf, while in *Fraxinus* and *Quercus* it was the other way round.

The CO_2 incorporating ability of the bark in summer and autumn respectively, was also examined. When comparing the data (Table 2) no considerable difference in the photosynthetic activity was found. According to the observations, in the case of *Euonymus* CO_2 incorporation in the compound of high molecular weight was lower in autumn than in summer. Similar results were obtained with the other two species too.

In light- and electron microscopic studies it was found that while chloroplasts occurred everywhere in the bark, the ones having ultrastructures similar to those in the leaf chloroplasts were found mainly in the third and fourth cell rows following the phelloderm. The electron microscopic picture obtained suggests, that the chloroplasts in these few cell rows are primarily responsible for CO_2 incorporation in the bark. The structure and assimilation starch content of the chloroplasts in the inner layers of the bark do not exclude, in principle, the possibility of a certain extent of photosynthesis, however, there is no actual physiological study now in progress to support this theory.

Plastids found in the medulla — as it has been mentioned — contain very large starch grains which suggests first of all their storing character. On the basis of the green colour and chlorophyll content of the plastids and the

Table 2

Seasonal changes in the direction of CO_2 incorporation in the bark

Material	Month	chl $a + b$ / g fresh weight	^{14}C in high molecular weight compounds %
Euonymus	July	561	6.6
	October	257	2.0
Quercus	July	161	25.6
	October	246	5.8
Fraxinus	July	67	15.7
	October	83	6.9

granules found — though in a low number — in them, it can be imagined that they may have some function related to photosynthesis.

The relatively low CO_2 incorporation of *Euonymus* bark compared with the leaf suggests that, beside the high chlorophyll content, the rate of CO_2 diffusion or anatomical limiting factors (e.g. few and narrow intercellular spaces, a low number of stomata and lenticellae, — CO_2 transmission of the epidermis and phelloderm — cell-wall thickness, concentration of the cytoplasm and other resistance factors) may become dominant.

A comparison between CO_2 incorporation in summer and autumn shows that the summer products of photosynthetically incorporated CO_2 are different from its autumn products. Namely, in summer CO_2 incorporation in the compounds of high molecular weight was considerably greater than in autumn.

Acknowledgement

The authors are indebted to Mrs. E. B. Szikszay and Mrs. P. Petrovits for their technical collaboration, and to Miss Zs. Bunke for her having prepared the drawings.

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ANATOMY OF VEGETATIVE FOOD STORAGE ORGANS

I. ROOTS

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The anatomy of specialized roots (modified for the purpose of food storage) of the following plants has been investigated: (1) *Brassica rapa* (2) *Discorea bulbifera* (3) *Ipomoea batatas* (4) *Manihot esculenta* (5) *Raphanus sativus.* It has been seen that they: *(i)* have a well-developed periderm which arises earlier in ontogeny (when the organs have just started to store food material); *(ii)* possess mostly parenchymatous tissue, which is most suited for storage ; *(iii)* exhibit a relatively poor development of vascular elements; *(iv)* are composed of cells rich in ergastic substances in the form of druses and raphides; and finally, *(v)* show absence of intercellular spaces in the parenchyma. These roots, although they perform an identical function and possess an uniform ground plan, have variable organization depending upon whether the plant is a dicot or a monocot. The arrangement of vascular tissues, latex cells, mucilage ducts, the extent of periderm formation, the types and frequency of starch grains and ergastic substances, etc. also appear to be determined by the genetic make up of the species.

Introduction

The angiospermous plants propagate from one generation to the other either by seeds or by some vegetative organs such as stems, roots, or even leaves. Whatever be the mode of reproduction, all the parent plants store some food to be used by the next generation in its early stages of development. Thus it is clear that all seeds and perennating roots and shoots store food material in some form or other. The inherent question is why the plants have selected only this kind of organs for this purpose and what is unique about their structural organization? Another point worthy of consideration is whether the structure of all the food storing organs (in different plants) is the same in view of a similar function being performed by them or is it controlled genetically?

The significant contributions in this regard are those of Hayward (1938), Artschwager (1924, 1926), Esau (1940), and a few others. It is, however, well recognized that the number of plants studied from this point of view is much fewer than those actually known to possess these features. In order to answer some of these questions studies have been undertaken to understand the organization and internal structure of various food storage organs, expecially those of the common angiospermous taxa. The first article in the series deals with roots.

Material and Method

Five plants, representing four families have been chosen for this study. These are:

S. No.	Name of plant	Family	English	Vernacular (Hindi) name
1	*Brassica rapa* Linn.	*Brassicaceae*	Turnip	Shalgam
2	*Dioscoreae bulbifera* Linn.	*Dioscoreaceae*	Dioscorea	Ratalu
3	*Ipomoea batatas* (Linn.) Lamk.	*Convolvulaceae*	Sweet potato	Shakarkandi
4	*Manihot esculenta* Cranta	*Euphorbiaceae*	Tapioca	Cassava
5	*Raphanus sativus* Linn.	*Brassicacaceae*	Radish	Muli

The specimens, in the form of vegetables, were obtained from the local market. *Manihot esculenta* roots were collected and fixed earlier from a plant growing at the Departmental Garden. Half of the fresh material in each case was fixed in FAA for 24 hours and stored in 70 percent ethyl alcohol. The other half was kept in a frigidaire until it was sectioned. Sections were cut (both transverse and longitudinal) with the help of a sliding wood microtome. As far as possible complete sections were aimed, but many times, due to the large volume of the specimens, the latter were cut into pieces. The section thickness varied from 26 to 40 μ, depending upon the texture of the material. It was, therefore, fixed in FAA for 24 hours and dehydrated in ethyl alcohol-xylol-series. Later it was sectioned with a rotary microtome at 10 μ.

The sections were invariably killed in 70 percent ethyl alcohol, and stained with safranin, dehydrated and mounted in canada balsam. In general they did not stain sufficiently well with safranin owing to the lack of lignified parts. Thus some of the sections were not counterstained with fast green at all.

Results

1. *Brassica rapa* L.

The root and some parts of the hypocotyl, which are underground, constitute the succulent portion of the plant which is eaten as a vegetable. The edible part is a modification of the primary tap root system. It is generally spherical and usually tapers abruptly (napiform).

The primary root has a diarch protostele (Fig. 20). The distinction between proto- and metaxylem elements is difficult, as almost all the vessels are of uniform size and occur in rows. Each vessel is surrounded by parenchyma cells of variable shapes (Fig. 2). The pith parenchyma is somewhat elongated and stretched. A few isolated xylem strands occur in the region of the pith and also in the outer cortex. The phloem is very scanty. The cortex is large and parenchymatous, separating the xylem strands wide apart. The outer cortex is made up of large elongated cells which are overlapping. This region is rich in tracheidal elements scattered in groups of 2—7 or even more. The outer cortical cells are rich in starch grains, the latter having a prominent hilum and being rounded (Fig. 10). The cortical layers, occurring just below the epidermis bear large raphides (Fig. 11).

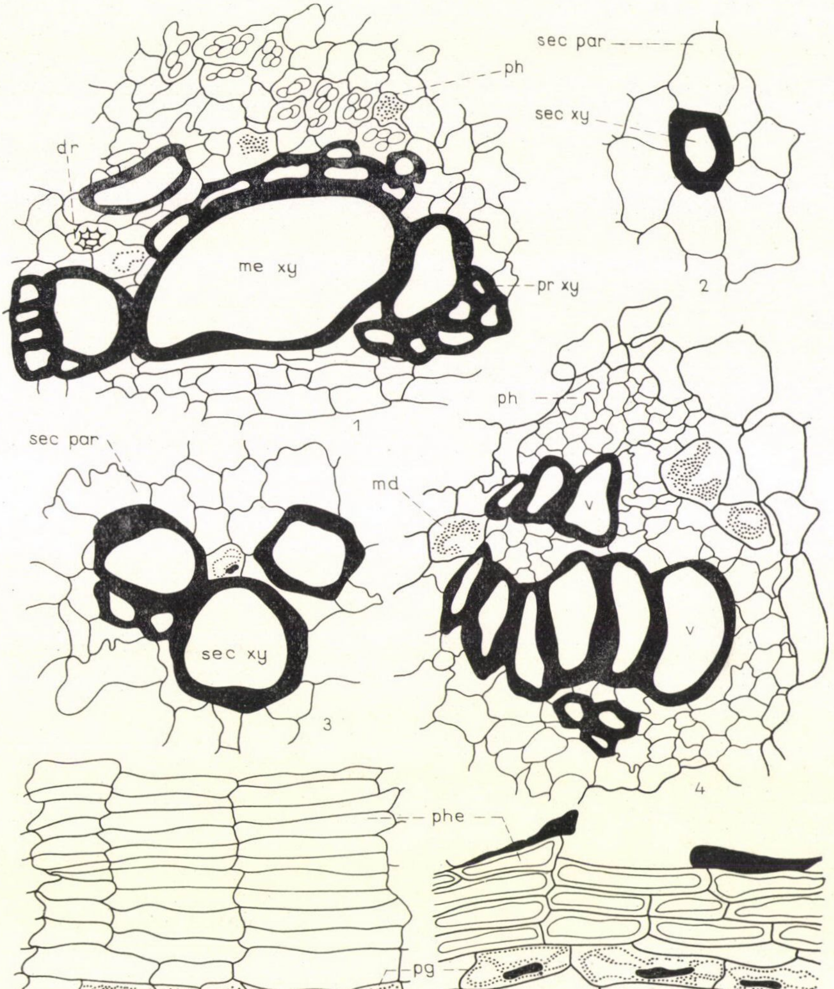


Fig. 1. Ipomoea batatas, an isolated vascular bundle showing large vessels, metaxylem in the centre and the protoxylem on the edges; xylem is surrounded by phloem and parenchyma. ×400

Fig. 2. Brassica rapa, a few secondary xylem elements accompanied by parenchyma. ×400

Fig. 3. Raphanus sativus, a few secondary xylem elements along with parenchyma. ×400

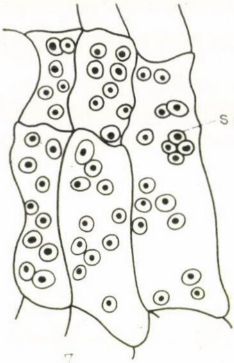
Fig. 4. Dioscorea bulbifera, single vascular bundle with a number of vessels, phloem and parenchyma; note the larger size of ground parenchyma cells (lying on the border of the bundle) as compared to those of the vascular parenchyma. ×400

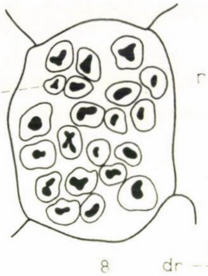
Fig. 5. Manihot esculenta, part of the T. S. of root; note the 11 layers of cork and a single layer each of phellogen, and phelloderm; the phelloderm cells contain druses. ×400

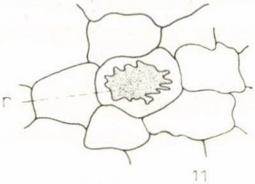
Fig. 6. Dioscorea bulbifera, three layers of thick-walled phellem, single layer of phellogen, and 2 layers of phelloderm. ×400

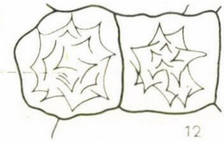
2. *Dioscoreae bulbifera* L.

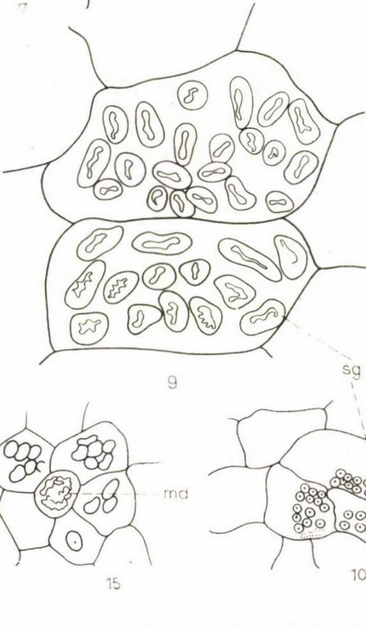
The tuberous roots which are conical to napiform and possess a large number of lateral branches primarily consist of ground parenchymae with vascular bundles scattered in them throughout. The ground parenchyma is

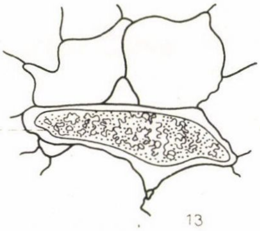


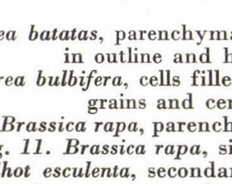


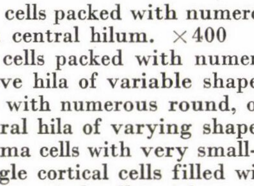












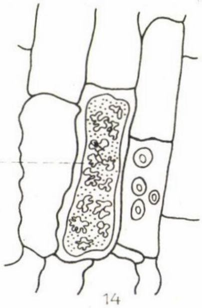


Fig. 7. Manihot esculenta, parenchyma cells packed with numerous round starch grains having a central hilum. ×400

Fig. 8. Ipomoea batatas, parenchyma cells packed with numerous starch grains which vary in outline and have hila of variable shapes. ×400

Fig. 9. Dioscorea bulbifera, cells filled with numerous round, oval, elongate, reniform starch grains and central hila of varying shapes. ×400

Fig. 10. Brassica rapa, parenchyma cells with very small-sized starch grains. ×400

Fig. 11. Brassica rapa, single cortical cells filled with raphides. ×400

Fig. 12. Manihot esculenta, secondary cortical cells with conspicuously large druses. ×400

Fig. 13. Raphanus sativus, a few cells of the secondary cortex and a laticifer. ×400

Fig. 14. Manihot esculenta, a cell of the secondary cell with a laticifer. ×400

Fig. 15. Dioscorea bulbifera, a mucilage duct surrounded by 5 radiating parenchyma cells. ×400

protected by the presence of periderm, a 3—6 layered periderm (Fig. 6). The cork cells are thick-walled.

The cells of the ground parenchyma are penta- to hexagonal, thin-walled and compactly filled with starch grains (Fig. 9). The latter are oval with a central hilum (hila of various shapes such as long, lobed or circular are also seen). The starch grains are without any thickenings. The outer ground parenchyma has few or no starch grains at all. The outer cells also bear raphides. The ground parenchyma cells have a large number of isolated mucilage canals (ducts). Each canal is surrounded by 5—7, characteristically organized radiating cells (Fig. 15). The latter possess dense cytoplasmic contents.

The vascular bundles comprise of 2—15 vessels and a few phloem elements (Fig. 4). Vessels have reticulately thickened walls. Phloem elements are usually not easily discernible.

3. *Ipomoea batatas* (L.) Lamk.

The edible starch-storing part assumes various shapes and sizes and is almost always underground. The morphology of this part has been controversial for many years but with the help of anatomical methods its "designation" as root has not only been strengthened but also confirmed (see GOVIL 1969).

The primary structure of the root shows a big, central metaxylem surrounded by four to six protoxylem elements alternating with a corresponding number of phloem groups (Fig. 1). The phloem and xylem groups are separated by parenchymatous cells. The former are poorly developed and each of them encloses a latex canal. The endodermis surrounds the single-layered pericycle. The cortex forms the major part of the root consisting of 8—12 layers of parenchymatous cells which are broad and tangentially elongated. It is enclosed by the epiblema on the outside.

The abnormal pattern of secondary growth in *Ipomoea* is worth mentioning. It has been studied in detail by ARTSCHWAGER (1924), and GOVIL (1969). Increase in the diameter of the large fleshy root is caused not only by a continuous cambium but also by the secondary cambia that arise within the secondary xylem. The endodermis of the young root is very prominent. The cambium produces a new xylem and phloem which break the endodermis. In the cortex the cells divide to keep pace with the increasing girth of the root. The divisions of the cells, derived from the cambium produce abundant xylem parenchyma, with scattered areas of water conducting tubes. The parenchymatous cells are full of starch grains with a central hilum (Fig. 8). The secondary cambium is differentiated from the xylem parenchyma surrounding each of these strands or around single water conducting tubes. This results in the increase of xylem parenchyma and accounts for the increase in the diameter of the sweet potato. This process is repeated many times.

4. *Manihot esculenta* Cranta

The root constitutes the edible part which stores starch. It is sufficiently hard and is consumed either raw or boiled. The roots are of large size and copiously branched.

The primary root has a tetrarch protostele (Fig. 19), a large metaxylem in the centre and four protoxylem strands radiating outside. The phloem is placed alternating with protoxylem strands of primary xylem. The large

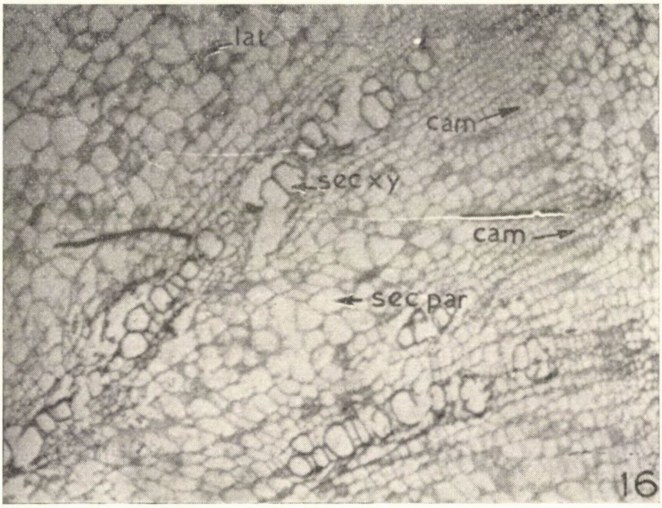


Fig. 16. Raphanus sativus, outer portion of root exhibiting cambium and secondary tissue. ×353

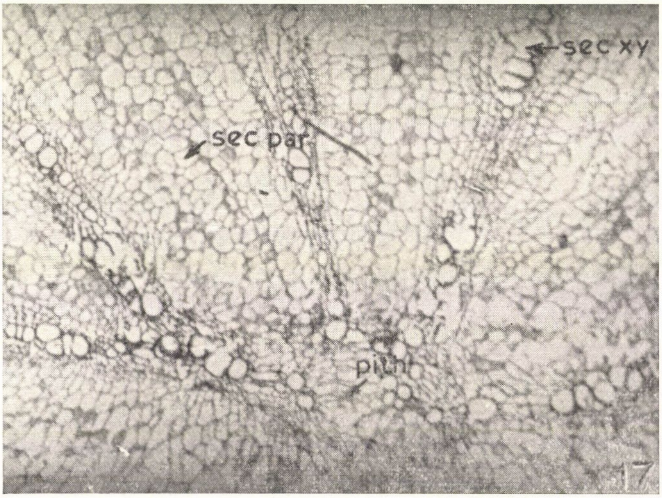


Fig. 17. Raphanus sativus, part of central region of root-including pith and secondary tissue. ×353

secondary tissue does not displace or destroy the primary tissue. The cambial activity results in the formation of an accentric secondary xylem consisting of large vessels arranged in radial rows (Fig. 18). The vessels are invaded by numerous, large tyloses and are surrounded by patches of thick- and thin-walled parenchyma. The secondary phloem is scanty.

The vascular tissue is markedly concentrated in the centre. The cambium in the outer cortical region produces much of the vessels and only a few phloem

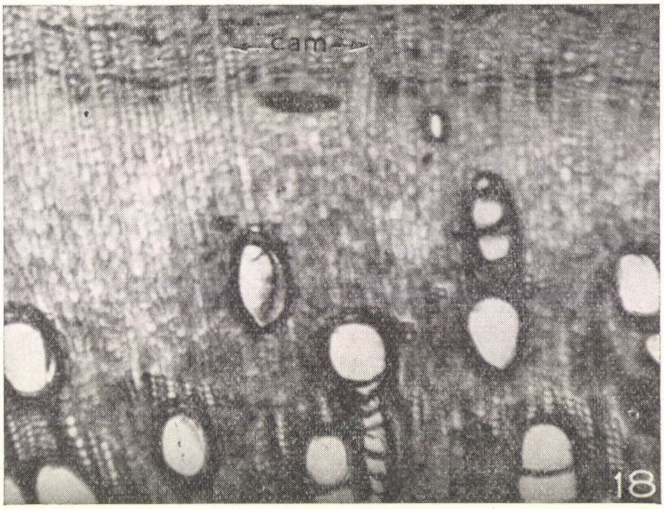


Fig. 18. Manihot esculenta, outer region of root showing multilayered cambium, thick- and thin-walled secondary parenchyma and secondary xylem. ×353

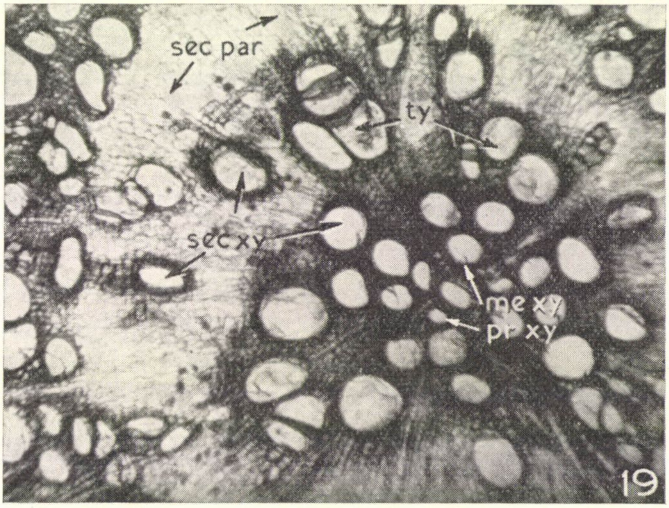


Fig. 19. Manihot esculenta, centre of the root showing primary and secondary tissues. ×353

strands (elements). In the outer, cortical region the vessels are also surrounded by thickened parenchyma, separated intermittently by thin parenchyma. The peculiarity of all the parenchymatous cells is that they are radially elongated. All the parenchyma cells are highly packed with starch grains (Fig. 7).

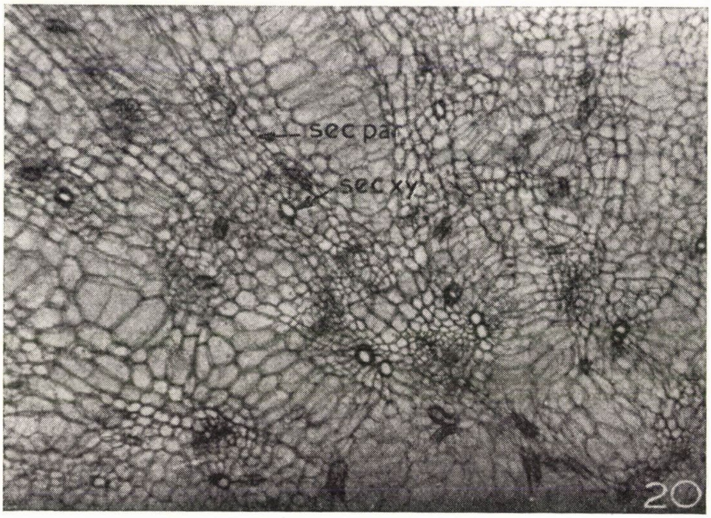


Fig. 20. Brassica rapa, part of root along with pith and secondary tissue. ×353

The outermost portion of the root consists of a 5—10 layered cork (Fig. 5). Cork cells are rectangular, thick-walled with little lumen and scanty cytoplasm. Immediately below there are rectangular cortical cells present. These are also thick-walled and possess dense cytoplasmic contents. Many of the cortical cells contain druses (Fig. 12) and latex (Fig. 14) and stain deeply. The thick-walled cells and the presence of latex tubes give the bark a dark tinge.

5. *Raphanus sativus* L.

The root and hypocotyl constitute the succulent portion of the plant which is generally eaten fresh. The fleshy axis is variable in size, shape, and colour depending upon the variety. It may be spherical, bluntly cylindrical or conical and much elongated. The colour usually ranges from creamy white to pink. The tap root may penetrate the soil to a depth of two to three feet. The root has an elaborate lateral spread (with numerous branchlets) but the upper portion of the fleshy primary axis of the hypocotyl is practically devoid of lateral roots.

The primary root exhibits a diarch protostelie condition. The cells of the two metaxylem points are differentiated centripetally and with the larger metaxylem vessel towards and at the centre, forming the complete primary xylem strand. The two primary phloem strands alternate with the protoxylem and are separated from the primary xylem by a zone of parenchyma. The cortex comprises a few layers of large parenchymatous cells and the epidermal cells are also thin-walled. This region also has several laticeferous ducts (Fig. 13).

During the initiation of secondary thickening the cambium arises in the fundamental parenchyma located between the xylem and phloem.

The mature root has a well organized periderm. The phellogen is in the form of a broken layer and the cork development is also poor. The secondary xylem vessels are arranged in radial rows, separated from each other by the parenchyma (Figs 3, 16, 17). The lignification of vascular elements is not so distinct either. Large quantities of thin-walled parenchyma account for the succulence of the edible root-hypocotyl axis. There is a great variation in the size of the vessels. In general, however, they are relatively large. Each vessel is surrounded by thin-walled parenchyma cells. Tertiary thickenings of the hypocotyl are identical to those of roots (Minin 1928).

The root cells largely contain water and cellulose. Thickened cells of the hypocotyl region accumulate glucose or fructose or both (reactions with Fehling's A and Fehling's B were positive).

Discussion

As detailed here, along with some other forms such as *Beta vulgaris* (beet) and *Daucus carota* (carrot), the plant organs modified for food storage show certain features which appear common and characteristic to all. These are summarized below:

A) Almost all the vegetative food storage organs are provided with thick-walled, rectangular, closely packed cork cells devoid of any intercellular spaces. The periderm arises earlier in the ontogeny (when the organ has just started to store food material). The cells may contain only a scanty amount of cytoplasm. What is the need for such a tissue while inside it extensively consists of parenchyma? Perhaps it is so organized to safeguard the organ from fungal attacks of various pathogens. As the perennating organ has to lie buried underground during the unfavourable season, there is every possibility of such an invasion. It is perhaps for this reason that the periderm is found usually as well as exclusively surrounding the tubers, rhizomes, corms, and root etc. Another possibility may be to check the loss of water content of the cells inside. As is known most of these types of organs are quite rich in water, they are liable to be attacked by pathogens and, therefore, must be protected by a relatively dry, unpenetrable and resistant periderm.

B) The presence of a large amount of parenchyma which is undoubtedly most suited for storage is the next important feature. Owing to their thin walls, these cells provide more space for storage.

C) There is relatively poor development of the vascular tissue. It can be discussed under two headings:

a) Dicotyledons, exhibiting secondary growth.

b) Monocotyledons, devoid of secondary growth.

A feature worthy of record in this connection is that the secondary tissue derived from cambial activity is dominated by the parenchyma, xylem and phloem formation being relatively very poor (except in *Manihot esculenta* which has numerous xylem vessels scattered all round). Here too, this tissue is comparatively very small in comparison to others.

In the monocotyledons the parenchyma invariably dominates and only a few elements of xylem and phloem are discernible.

D) Latex usually occurs in the food storage organs. It may be replaced by mucilage in some instances as in *Dioscorea bulbifera*. It provides good evidence for the belief that the latex is one of the reserve food materials rather than a mere waste product.

E) The presence of abundant starch is characteristic of all the plants studied, indicating preference of this mode of storage over any others.

F) Profusely distributed ergastic substances such as druses and raphides are also characteristic of such organs. There are again two possibilities; either they provide strength (by keeping the cells in a stretched condition) or they are storage products. Their description as waste (excretory) products is again debatable.

G) Last, but perhaps most important of all, is the feature that brings out the economy of plants. It is the absence of intercellular spaces in parenchyma. It may be because of two reasons: a) it provides more strength due to the compactness of the organ or b) it utilizes the maximum area available.

Some of these and related problems will form the subject matter of the discussion in our second article on "stems".

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HETEROGENITY OF MYOSIN, AND SPECTROFLUOROMETRIC INVESTIGATION OF ITS CHROMATOGRAPHIC FRACTIONS

By

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The present paper deals with the heterogeneity of myosin, and discusses the structures of chromatographically separated myosin fractions as investigated on the basis of excitation- and fluorescence spectra. The myosin was separated into 4 protein- and 2—3 lipid fractions on a DEAE-cellulose column; their Ca-ATP-ase activity of AMP-desaminase and cholinesterase associated with myosin were examined. All four protein fractions were found to possess ATP-ase activity, while only fractions I, I/a, and IV had cholinesterase activity. Among the fractions only fractions II and III can be considered as pure myosin as they have only ATP-ase activity. No enzyme treatment was applied until the myosin had been submitted to chromatography. No enzyme activity could be detected in the lipid fractions. The absorption spectra as well as the quotienst E_{280}/E_{260} calculated from their extinction at 280 and 260 mm, respectively, were different with protein- and lipid fractions examined. The excitation and fluorescence spectra of the protein fractions obtained are compared and discussed. They demonstrate the corresponding and compound fractions. The excitation- and fluorescence spectra of lipid fractions are of low intensity probably due to residual protein; namely, freshly produced lipids have hardly any absorption, their spectra are characterless and flat, while maxima both in the excitation- and fluorescence spectra of peroxidized lipids are shifted to longer wave lengths.

Introduction

Myosin is a "giant" molecule, it is therefore complicated to produce and study. The heterogenity of the myosin has a double meaning which gives rise to misunderstanding. Firstly, myosin is associated with two enzymes: cholinesterase (acetyl-choline esterase E.C. 3.1.1.7) and adenosine desaminase (AMP-aminohydralase E.C. 3.5.4.6). Choline esterase is very intensively absorbed (Vodnyánszky *et al.* 1962); Varga *et al.* (1935) pointed out that choline esterase is found in the L-meromyosin part. Adenosine-desaminase is also very closely linked with myosin (Székessy—Hermann—Josepovits 1949a, 1949b; Székessy—Hermann—Zombori 1954). Secondly, myosin is heterogenous even without these enzymes and can be reduced to various chromatographic fractions.

Neither has it been stated whether the small subunits of 17,000, 19,000 and 20,000 molecular weight, respectively, isolated by Locker—Hagyard (1966a, 1966b, 1967), and the subunit of 46,000 molecular weight obtained by Dreizen *et al.* (1966) with guanidine HCl treatment, as well as peptids of an average molecular weight of 20,000 are identical with the activity of one of the enzymes, or are inactive components.

We have arrived at the conclusion that myosin shows heterogeneity even without acetyl-choline esterase- and adenine-desaminase activities.

Aromatic amino acids found in the myosin make the ultraviolet spectrophotometric investigation of the structure possible. Discovering its secondary and tertiary structures and the structure of the active centre is not a simple task which requires the joint application of more than one methods. One of these methods is the spectrofluorometric examination of myosin which is a closer approach to the question.

The fluorescence spectrum of myosin was studied by DUKE *et al.* (1966). CHEUNG—MORALES (1969) prepared myosin according to SZENT-GYÖRGYI's (1951) method modified by TONOMURA *et al.* (1966) for studying its fluorescence spectra, and measured the maximum of the emission spectrum at 345 mm. Some authors try to obtain data on the structure of myosin by studying the ultra-violet- and fluorescence spectra after its modification. The modifying effect of urea, present in various concentrations, on the intensity of the fluorescence spectra of myosin was studied by STRANKFELD (1970) who found that urea up to a concentration of 1.5 M increased the intensity of fluorescence, and ATP-ase activity increased parallel with it. With concentrations higher than that both decreased.

CHEUNG—MORALES modified the fluorescence spectrum of myosin with 8-anilino-1-naphtalene sulphonic acid. In the concentration of 8-anilino-1-naphtalene sulphonic acid the fluorescence of tryptophan ($\lambda_{\max} = 345$ nm) is considerably shifted and a second peak appears around a maximum of 475 nm. This later peak originates from the 8-anilino-1-naphtalene sulphonic acid. It was found that the reagent was bound only with the heavy meromyosin fraction and changed its fluorescence intensity. The data are used to draw conclusions on the position of the tryptophan and the structure of the heavy myosin fraction. It is easy to understand that some authors only chose the fluorescence study of heavy meromyosin as the subject of their experiments, (e.g. TAKASHINA (1970)) as the active centre of ATP-ase is localized to the heavy meromyosin fraction.

In our experiments we found that in the chromatographed preparations the fluorescence intensity of myosin changed with time. We supposed that the fluorescence spectra of myosin was not exclusively determined by amino acids building up the protein, but also by other substances of lipid character successfully isolated from the chromatographed fractions. On the other hand, we succeeded in reducing myosin to more than the usual number of chromatographic fractions, of which four had independent and characteristic ultra-violet spectra and characteristic E_{280}/E_{260} quotients. On this basis we have to agree with the authors — ASAI (1963), MOREY *et al.* (1967), VIERLING *et al.* (1968) BARIL *et al.* (1967) — who consider myosin heterogenous, i.e. composed of various molecules.

Material and Method

In our experiments we used myosin isolated from rabbit skeletal muscle with SZENT-GYÖRGYI's (1951) method modified by PORTZEHL—SCHRAMM—WEBER (1950). The myosin was centrifuged for an hour at 105,000 g and chromatographed on a DEAE-cellulose (Whatman DE 32) column, after the method of MOREY *et al.* (1967). With a low gradient of Cl^- concentration, in a pyrophosphate buffer of 0.04M (pH = 7.6) myosin is reduced to a well defined protein fraction and two not readily separated fractions already appearing at the beginning of the elution. The readily separated fraction is usually called myosin in the literature. This method is not satisfactory for separating the various fractions of myosin, which is proved by the percentage distribution of fractions and also by the recovering ability. We tried to develop a method resulting in myosin perfectly bound and 100 per cent recovered. This was prevented by the high solubility of myosin. Nevertheless we succeeded in achieving a better separation by decreasing the concentration of the pyrophosphate buffer to 0.02 M and that of the chromatographed myosin to 5—6 mg/ml simultaneously.

With the above method, at the end of the isolation myosin was prepared in a concentration of 20—30 mg/ml in 0.5 M KCl and 0.05 M 2-mercapto-ethanol solution for chromatographic separation. By reducing the KCl concentration to 0.04 M the myosin was precipitated and collected by means of a centrifuge (2500 g, 30 minutes, 0° C). This process was repeated four times, then the myosin was dialized against a 0.02 M pyrophosphate buffer in order to remove the KCl perfectly. In such circumstances myosin can be perfectly bound on a column equilibrated with 0.01 M pyrophosphate (pH 7). Elution was carried out step-by-step and started with pyrophosphate of 0.02 M (pH 7.6). Further eluants applied are given in Fig. 2. The ATP-ase activity of myosin was determined with the method of HOLLAND—PERRY (1969). The concentration of an inorganic phosphate originating from the splitting of the ATP was determined by the method of FISKE—SUBBAROW (1952) and the ascorbic acid reduction was achieved by a modified method of LOWRY *et al.* (1954). The amount of protein was calculated from Kjeldhal's nitrogen content determination and determined on the basis of extinction measured with a Beckman DU spectrophotometer Model G 2400 at 280 nm in the ultraviolet region (YOUNG 1967). Data were controlled by gravimetric measurements of preparations dried at 105° C.

Fluorescence methods. The fluorescence measurements were carried out with a HITACHI—PERKIN—ELMER MPF 2/A spectrofluorimeter and the conventional optical system for the detection of fluorescence at 90° relative to the path of excitation light. A 1 cm long quartz cuvette was used. The excitation of the samples took place at a wave length of 280 nm. The diffuse light was filtered out at 290 nm by means of a cut-off filter. (Except for Fig. 5.) The width of the excitation and emission band was 2 nm. The excitation light-source was a Xenon lamp of 150 W.

Results

A considerable part (20 percent or sometimes more) of the myosin chromatographed with the method of MOREY *et al.* (1967) is not bound on the DEAE-cellulose column. Beside the main fraction — fraction 3 — fractions 1 and 2 (Fig. 1)* also exhibit ATP-ase activity. Some 35 percent of the total ATP-ase activity, while only 26.7 percent of the protein tested are contained in fraction 3. After fraction 3 a substance of non-protein character eluates, up to 90 tube, and 60—62 percent of the material applied to the column is recovered when expressed in E_{280}. The rest consists of fractions 4 and 5 which contain an insignificant amount of protein eluating with alkali. The ATP-ase activity of

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* In order to avoid confusion we mark the fractions from linear gradient chromatography with 1, 2 and 3, while the concentration gradient fractions with I, II and III, as seen in Fig. 2.

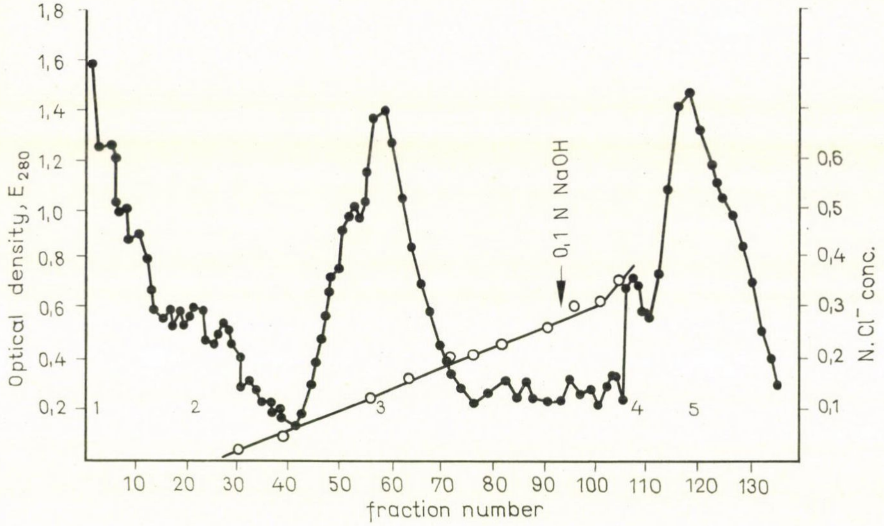

Fig. 1. Chromatography of myosin on DEAE-cellulose column according to the method of Morey et al. (1967). Column is 2.3 cm in diameter and 45 cm in length. Fraction volume 6.2 ml. Elution was fulfilled with KCl linear gradient. Lipid eluted with 0.1 N NaOH

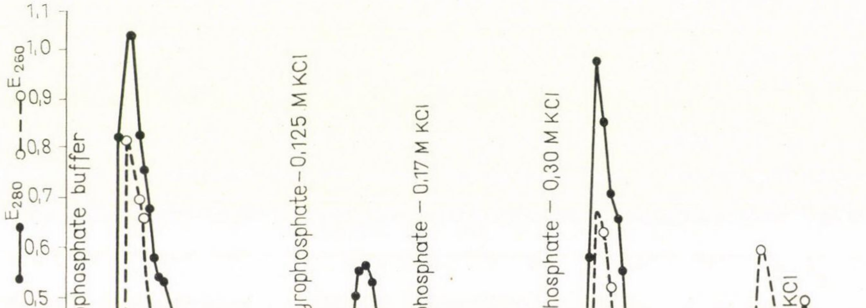

Fig. 2. Chromatography of the ultracentrifuged myosin on DEAE-cellulose column. Protein of 311.8 E_{280} in 0.02 M pyrophosphate buffer (pH 7.6) applied for column. Column is 2.3 cm in diameter and 50 cm in length, equilibrated with 0.01 pyrophosphate buffer containing 0.02 M 2-mercaptoethanol (pH 7.6). Fraction volume 6.2 ml. Lipid eluted with 0.9, 1.1, 2 M KCl. .—–.E_{280}, ——E_{260}

fractions 3 is 0.17 micromole P_i (mg protein) minute. The ATP-ase of the main fraction is not activated by Mg-ions. It shows cholinesterase activity and about 30 μg acetylcholin is hydrolized by 1 mg protein in 60 minutes.

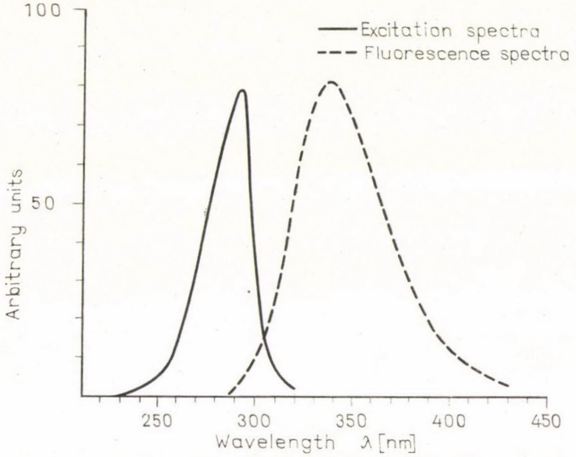

Fig. 3. Excitation and fluorescence spectra of myosin chromatographed by the method of Morey et al. (1967)

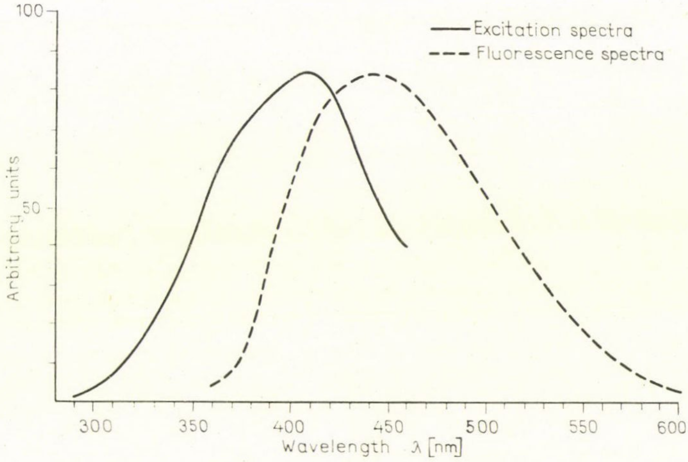

Fig. 4. Excitation and fluorescence spectra of lipids in chloroform. Lipids were extracted from myosin with chloroform : methanol (" : 2 v/v)

In Fig. 1, on the asymmetric ascending side of the chromatographic curve of fraction 3 a minor peak is found which shows that the fraction is not homogenous, as confirmed by the results of studies on the fluorescence- and excitation spectra.

With the chromatographic technique described in the methodological part of the paper myosin can be perfectly bound on the DEAE-cellulose column;

a hundred percent elution can be achieved, and furthermore NaOH solution as eluant omitted. With this procedure five fractions with protein content and ATP-ase activity as well as two or three fractions consisting of lipids and some nucleic acid eluating under the influence of higher concentrations of KCl are obtained from the myosin (Fig. 2). The low concentration pyrophosphate buffer by itself eluates two fractions (I and I/a). Fraction I is heterogenous, its ATP-ase- and acetyl-cholinesterase activities are the lowest of all protein fractions. Fraction I/a has the highest acetyl-cholinesterase activity, but even its ATP-ase activity is twice as high as that in the fraction. Fractions II and

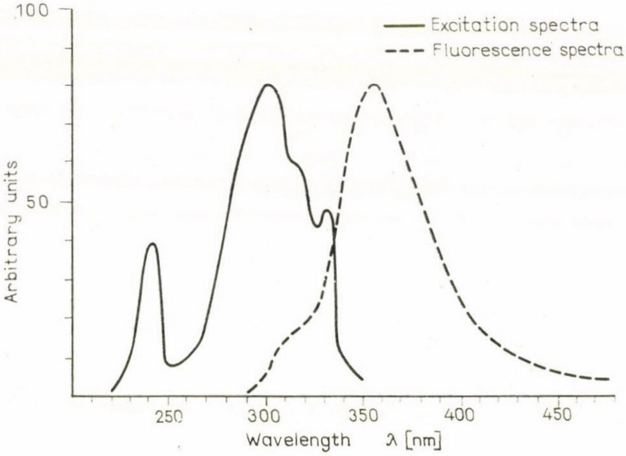

Fig. 5. Excitation and fluorescence spectra of extracted myosin, resoluted in 0.5 M KCl containing 0.02 M 2-mercaptoethanol

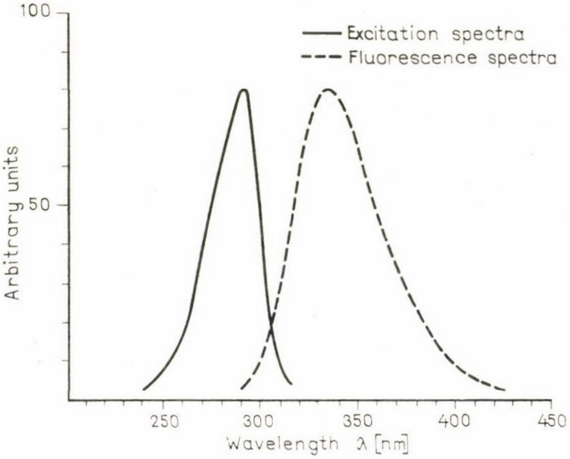

Fig. 6. Excitation and fluorescence spectra of fraction I gained with 0.02 M pyrophosphate buffer (pH 7.6)

III show only ATP-ase- and no acetyl-cholinesterase activity. Fraction IV displays a considerable cholinesterase activity and possesses about 70 per cent of the total activity. Fraction III differs from the others in that it remains in

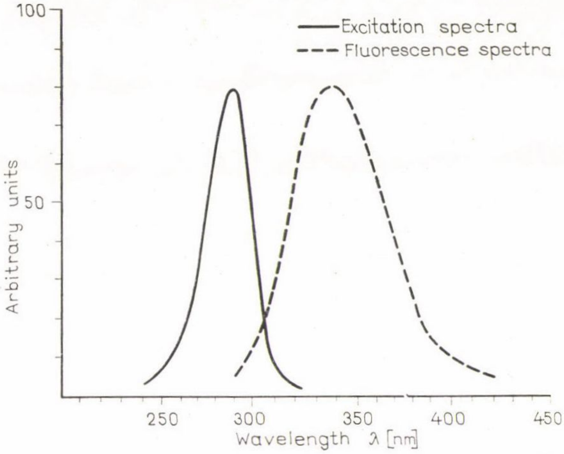

Fig. 7. Excitation and fluorescence spectra of fraction I/a. Eluted with 0.02 M pyrophosphate buffer (pH 7.6)

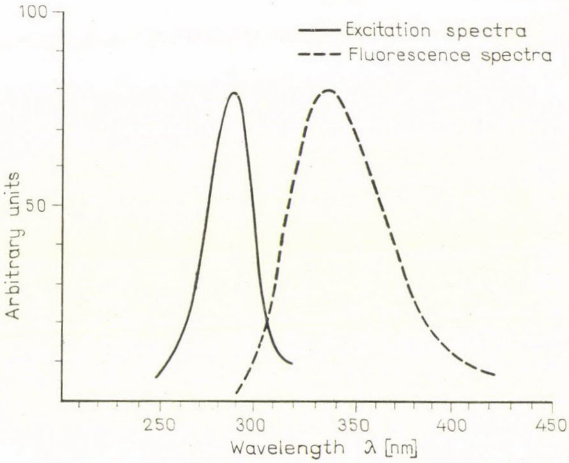

Fig. 8. Excitation and fluorescence spectra of fraction II eluted with 0.0025 M pyrophosphate — 0.125 M KCl (pH 7.6)

solution even when dialized against distilled water at a low concentration. The E_{280}/E_{260} quotients of the individual fractions increase compared to that of the applied myosin. While before separation they had 1.0—1.23 values, fractions obtained after the separation showed the following values of the E_{280}/E_{260} quotient: I = 1.23, I/a = 1.61, II = 1.42, III = — 1.82, IV = 1.54, and in lipid fractions obtained with high concentrations: V = 1.0, VI = 0.64 — 0.84. Quotients of fractions I and I/a vary from preparation to preparation.

Fluorescence spectra of fractions

Fig. 3 shows the fluorescence and excitation spectra of myosin obtained with fraction 3 presented in Fig. 1.

When the fraction was dialized over a longer period against distilled water, products of low molecular weight were released in the dializing water. When following up the amount of the released substance spectrophotometrically

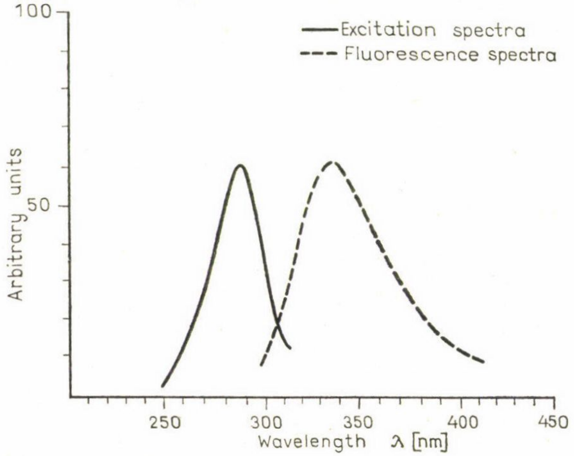

Fig. 9. Excitation and fluorescence spectra of fraction III eluted with 0.005 M pyrophosphate — 0.17 M KCl (pH 7.6)

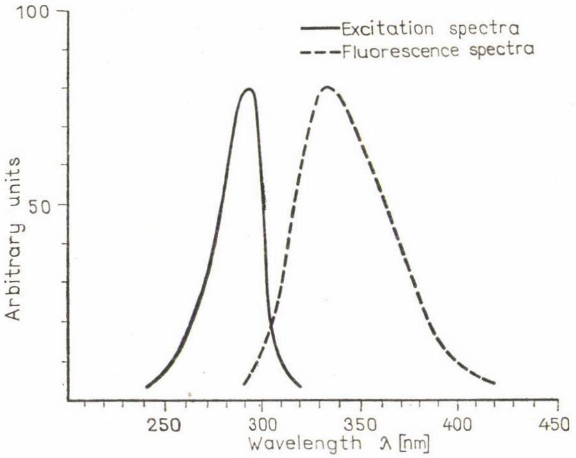

Fig. 10. Excitation and fluorescence spectra of fraction IV eluted with 0.01 M pyrophosphate — 0.30 M KCl (pH 7.6)

we found that the low molecular weight substances collected were about 20 per cent of fraction 3 when expressed by the value of E_{280}. Under the influence of dialysis the myosin precipitates, its ATP-ase activity decreases, and it becomes greyish when kept for some time in the open air which indicates the

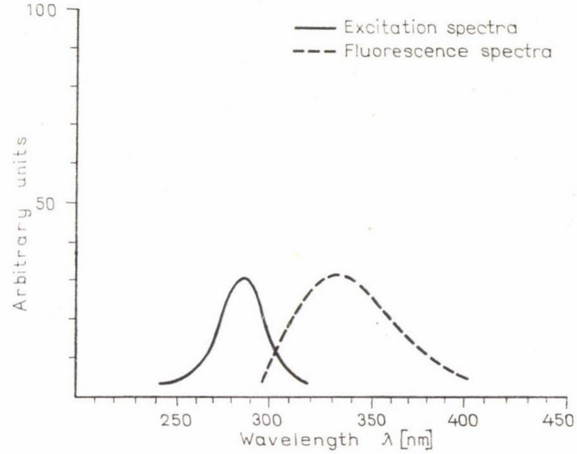

Fig. 11. Excitation and fluorescence spectra of lipid fraction V eluted with 0.9 M KCl

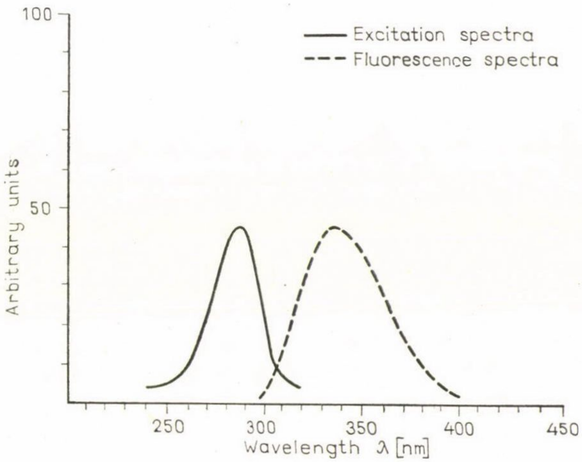

Fig. 12. Excitation and fluorescence spectra of lipid fraction VI eluted with 1.1 M KCl

presence of unsaturated lipids. The precipitated myosin was therefore extracted for 2—3 days with a tenfold volume of chloroform: methanol (2 : 1 v/v), and the extract concentrated. Lipid peroxids of yellow colour were thus obtained. The fluorescence- and excitation spectra of the lipid are shown in Fig. 4. The very wide excitation and emission spectra suggest that the substance in question is not homogenous.

The extracted myosin has no ATP-ase activity, 0.5—1.0 mg/ml myosin can be recovered to resolve in 0.5 M KCl. Its fluorescence- and excitation spectra are shown in Fig. 5.

Both the excitation- and the fluorescence spectra differ essentially from the spectra shown in Fig. 3. On one hand both spectra show more than one maxima, on the other hand the λ_{max}-s of the main peak are shifted toward the longer waves. This is caused by some components appearing as the result of the disproportion. The maxima appearing in the short wave range of the excitation spectra are considered by the literature as originating from denaturated protein aggregates, and thus the spectrum as one of scattered excitation radiation.

With the excitation spectrum shown in Fig. 5 at 350 nm a cut-off filter was applied to filter out diffuse light, and the intensity of emitted light was measured at the wave-length of 360 nm. The excitation- and fluorescence spectra of the chromatographed fractions shown in Fig. 2 are presented in Figs 6—10. Excitation- and fluorescence spectra of fractions I and IV are totally identical. When comparing them with fraction 3 of Fig. 1 we find that the excitation spectra are identical, but the fluorescence spectra are different. The maximum in the fluorescence spectra of fractions I and IV is somewhat shifted toward the short wave spectral range.

With fractions I/a, II and III both excitation- and fluorescence spectra are identical, but — unlike those of fractions I and IV — the maxima in the excitation spectra are also shifted toward the short wave range. At the same time the fluorescence spectra correspond to the respective values of fractions I and IV (Figs 7—9).

The fluorescence intensity of fractions V and VI is very low (when concentration is taken in consideration) compared to the former ones, about one-third or one-quarter of them (Figs 11—12). Their excitation spectra correspond to that of fraction I/a, while the maximum in their fluorescence spectra is slightly shifted toward the long-wave range as compared to those of the former fractions. The protein content of the fractions is low, and the lipids have not yet been oxidized to such an extent as to give a similar spectrum to that in Fig. 4.

Discussion

We have demonstrated by our experiments that with an adequate chromatographic method myosin can be dissociated to six fractions of which only fractions II, III and IV are considered myosin fractions. Although fractions I and IV have identical excitation- and fluorescence spectra, fraction IV has a considerable negative charge and — as a result — eluates from the DEAE-cellulose at higher KCl concentrations. ATP-ase activity of all three fractions is lower than that of myosin applied to the DEAE-cellulose column (0.45 μmol/mg/minute), but none of them show either AMP-desaminase activity or cholinesterase activity except fraction IV which has some cholinesterase activity.

The excitation maxima of fractions I/a, II and III are shifted toward the shorter wave range due, supposedly, to the higher susceptibility to activation of tyrosin occurring in the molecules as a result of structure transformation or the removal of the small sub-units and lipids. Disintegration is indicated by the increased quotient in the ultra-violet spectrum and the decreased ATP-ase activity compared to that of the myosin studied chromatographically. In Fig. 5 the wider excitation- and fluorescence spectra of lipid-free extracted myosin, the appearance and shifting of a number of small absorption- and emission maxima show that this fraction consists of more than one components, and the excitation- and fluorescence maxima of components appearing as a result of disintegration in the structure have shifted toward shorter $\lambda_{\max}$-s of tyrosine and longer $\lambda_{\max}$-s of triptophan, respectively. It is known that the fluorescence maximum of tyrosine is 304 nm and that of triptophan 350 nm. So tyrosine is able to influence the fluorescence spectra of proteins in the range between 295 and 305 nm, while triptophan between 340 and 355 nm wave-lengths. 4—6 percent lipid can be obtained from fraction 3 produced by the simple linear gradient method (Fig. 1). Lynn (1967) was able to isolate 4 percent lipid from chromatographically purified myosin. However, with myosin fractions obtained by the step-by-step method (Fig. 2) 2—3 percent lipid can be found even in

Table 1

Distribution of chromatographed myosin fractions

Fraction	No	E_{280}	%	ratio of E_{208}/E_{260}
I	1—56	54.0	25.7	1,28
I/a	57—102	37.0	11.3	1.53
II	103—146	45.6	13.8	1.42
III	156—168	35.95	11.0	1.80
IV	201—246	65.83	20.2	1.44
V	249—260	4.74	1.45	1.04
VI	261—283	23.82	7.65	0.74
VII	284—291	15.31	4.65	0.70

recovery = 311.8 95.6
applied for column = 327.5 100.0 1.28

the fractions of II and III. Moreover, with partial hydrolysis (in 2 M HCl, at 100° C for ten hours) a further 4.36 per cent lipid of intensive yellowish brown colour could be isolated from lipid-extracted myosin. Owing to their low excitation- and fluorescence activities lipids do not perceptibly influence the spectra except in the case of old discoloured myosin exposed to the open air, where autooxidation has already started. The spectrum of peroxidated lipid can be seen in Fig. 4.

Our results suggest that cholinesterase activity is divided in the fractions. The highest specific activity is achieved in fraction I/a. In spite of this fact fraction I/a cannot be considered pure cholinesterase either, as it shows a very high — 0.5 μmol Pi/mg/minute — Ca—ATP-ase activity as compared with the 0.20 mol Pi/mg/minute activity of fraction I. If the amount of fraction I/a is low, it cannot be isolated as a separate fraction and remains in fraction I.

Fractions II and III have no cholinesterase and desaminase activity. Fraction IV is a compound and contains cholinesterase, lipid and fractions II and III. Under the influence of high salt concentrations, or when rechromatographed these fractions reappear. It is for this reason that fraction IV is supposed to be the precursor of all the other fractions.

It is difficult to find out to what extent fractions obtained in our investigations with the gradient chromatographic method overlap components obtained by other authors. Eluents applied in the procedure may possibly result myosin sub-units isolated by DREIZEN *et al.* (1966), DREIZEN *et al.* (1967), GERSHMAN—STRACHER (1966), GERSHMAN—DREIZEN (1969) or small components considered necessary by DREIZEN—GERSHMAN (1970) and unnecessary by PERRIE—PERRY (1970) to maintain the Ca ATP-ase activity of myosin.

On the basis of our investigations and the results obtained it is not easy to decide to what extent fractions I, I/a, V, VI and VII can be classified as components of myosin, in contrast with the lipid contents of chromatographed fractions which are closely linked with protein.

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PRIMARY AMINATION MECHANISMS IN INTACT PINTO BEAN LEAVES WITH AN INCREASE IN THE GLYCINE LEVEL

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Detached leaves of Pinto bean plants grown in a soil poor in nitrate were infiltrated with KNO_3 solution, then placed in the dark. Changes in time of the levels of free cysteine, lysine, asparagic acid + asparagine, glutamic acid + glutamine, glycine, alanine, tyrosine, tryptophane, phenylalanine + leucine + isoleucine, methionine and proline were determined in the samples by means of paper chromatography. In the initial phase of the inductive synthesis of the nitrate-reductase enzyme there can be observed a general increase in the level of amino acids. There is an especially significant increase in the levels of glycine, alanine and glutamic acid. Between the fourth and seventh hour a general decrease can be observed in the level of amino acids, due probably to the new metabolic balance resulted from the rise in the exogenous nitrate level. The level of the free glutamic acid subsequently maintains its rising character. Data obtained support the idea that the role of the α-ketoglutarate and oxaloacetate is not exclusive, but their primary amination is possible. At the same time, primary amination can be demonstrated through other compounds as well, such as pyruvate and acetyl-KoA. The mechanism of primary amination in leaves differs from that observed in roots. Changes in the methionine- and tyrosine levels can be considered as characteristic from the point of view of induction, and cannot be expected — especially in the case of metionine — from the primary amination mechanisms.

Introduction

Although NO_3, NO_2 ions are always found in green plants, even when they could not enter the plant from outside (FRENYÓ 1966), their level does not induce the synthesis of the nitrate reductase enzyme which only occurs when the plants are placed in a medium containing NO_3 (BORNMAN 1965). Nitrate reduction may take place in a non-enzymatic way as well, with ascorbic acid as intermedium, but this process is quantitatively insignificant (BAR-AKIVA—STERNBAUM 1966). The root is the main site of nitrate reduction in plants; NO_3 appears in the aboveground parts only in the case of an extraordinary rise in the exogenous nitrate level. Here reduction takes place equally both in darkness and light, though in the latter case it is much more intensive (ROTH-BEJERANO—NURIT 1970).

According to PRYANISHNIKOV's data (1952) in green plants ammonia derived from nitrate may be bound to different keto-acids, so by primary amination various amino acids may be created. After the discovery of transamination α-keto-glutaric acid was found to have a key role in these processes in animal organisms. This finding was first thought — wrongly, as it turned out later — to apply to primary amination processes occurring in green plants too. For example: FRAUSTADT (1959) pointed out that pyruvate may be a primary amino acceptor in fungi. The same was proved by KRETOVICH *et al.* (1963), DUBINYINA (1965) with green plants. An intensive rise in the level of alanine can be observed again (MOYSE 1959, SMITH *et al.* 1961) in the case of nitrate reduction taking place in light in competition with photosynthesis (VOSKRESENSKAYA—GRISHINA 1962). A simultaneous increase in the serin level is the result of transamination from glycine (PRITCHARD *et al.* 1961, NICZIPOROVICS—ZAK 1964). According to FOWDEN (1967) it is α-ketoglutarate and oxaloacetate that take part first of all in the process of primary amination. This suggestion seems to be confirmed by MENGEL—HELAL (1968, 1969).

The greatest part of the work mentioned above was done with roots and *Chlorella* and knowing the fact that nitrate reductase synthetized in leaves differs in more than one respect — Mo sensitivity, co-factor specificity (SHAKED 1967, PANEQUE 1969, HATTORI 1966) — from that found in roots, it seemed necessary to study the process in leaves too.

Material and Method

Bean plants *(Phaseolus vulgaris* L. var. Pinto) used in the experiments were grown in a culture soil poor in nitrate. Leaves detached from the plants were vacuum-infiltrated with a 2.5×10^{-4} M potassium nitrate solution (SCHRADER 1967), then placed in a dark thermostat at a temperature of 25° C. Samples were taken in the 1st, 2nd, 3rd, 4th, 7th, 10th, 13th and 16th hour after the beginning of the experiment. After extraction in 80 percent ethanol, purification with Ashwattaman's method, evaporation and solving of the residue in 10 percent isopropanol, the amino acids were separated by means of paper chromatography with descending branch, in a system of butanol : acetic acid : water = 75 : 15 : 10, on a SS 2043 b Mgl paper (HAIS—MACEK 1961). After ninhydric staining the spots were eluated, and colour intensity was measured with Unicam SP 800A spectrophotometer at a wavelength of 570 mμ.

The results obtained were plotted in a co-ordinate system of time and absorption— on the average of four replications.

Results

Fig. 1 shows the temporal level changes of free amino acids. The process is divided into two distinct parts. After a general initial increase, with a peak in the fourth hour, the level of every amino acid examined falls until, in the fifth hour it reaches a minimum, and then only Gly, Ala (1.A), Glu+Gln (1.B) and Try (1.C) change their levels considerably.

Increased concentration of Gly and Ala in the first phase is especially remarkable (1.A). After a temporary decrease in the fifth hour Gly, Ala show a very slow increase, practically a stagnation between the seventh and eleventh hour, which reaches a plateau by the 16th hour. This is true for Asp+Asn as well, but at a considerably lower level (1.B).

Glu+Gln concentration maintains its increasing character even after the 13th hour (1.B).

In the first phase two peaks can be observed in the case of free methionine and tirosine. The former shows another maximum after the fifth hour, though it is not expressed.

After a temporary stagnation between the seventh and tenth hour the level of Tyr continues rising, and — judging by the character of the curve — probably reaches a maximum in the 16th hour (1.C).

Levels of the other amino acids examined remain low after a general decrease following the initial rise: Try, Pro (1.A), Phe+Leu+Ile (separation of these amino acids was not good in the system used), Lys (1.B), Cys (1.C).

Discussion

According to the results the free amino acids of the leaf show considerable changes in concentration under the influence of a sudden increase in the exogenous nitrate level. This statement corresponds with the findings of other authors who pointed out that NO_3 was intensively incorporated (MICHAEL *et al.* 1965; MARTIN 1968), and its effect on the protein content became obvious only several days later (KUTURIN 1956). In our case too, the "nitrate shock" led to a general rise in the level of free amino acids.

The level of free amino acids is controlled from two sides: partly by the processes of amino acid synthesis and decomposition, partly by those of protein synthesis and decomposition, respectively. In the given case the proteolytic processes probably play a subordinate role. The same cannot be said about the protein synthesis; HAVKIN *et al.* (1969) pointed out that nitrate reduction following the inductive synthesis of nitrate reductase involves the increased activity of other enzymes too, and the more intensive incorporation of alanine in the proteins. This is not, however, significant in the first hours.

According to the results obtained the process examined by us is divided into two well distinguished phases: one until the fifth hour and another after the fifth hour. This result corresponds with other authors' results obtained with other plants (barley, maize) and plant organs (MENGEL—HELAL 1969).

In the first phase there occurred a general increase in the amino acid level, that of the Gly, Ala, Glu+Gln and Tyr levels was, however, outstanding. This indicates that in the course of the primary amination not only the α-ketoglutarate and oxaloacetate but the pyruvate also plays a role, and there is a possibility too of primary amination occurring through acetyl—KoA formed in the course of cell respiration. Beside primary amination, increased transamination is also highly probable in this phase, unfortunately it cannot, however, be directly proved with the method applied.

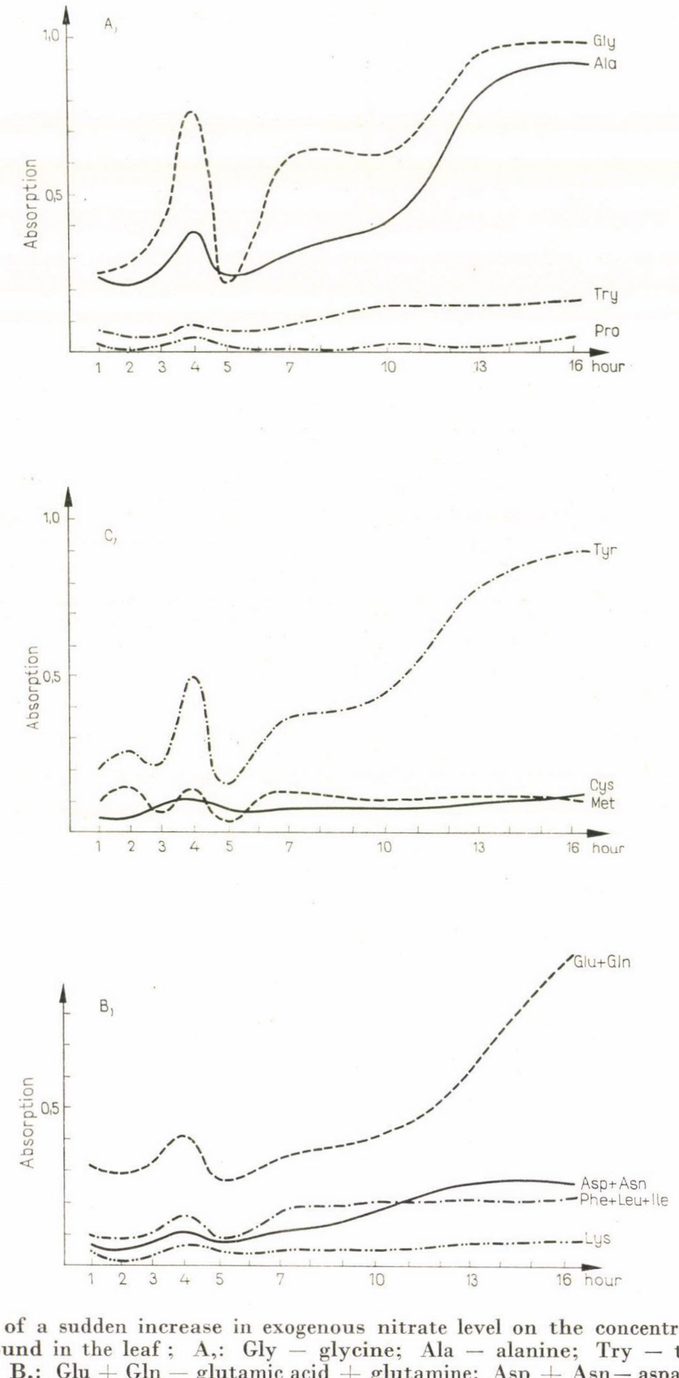

Fig. 1. Effect of a sudden increase in exogenous nitrate level on the concentration of free amino acids found in the leaf ; A,: Gly — glycine; Ala — alanine; Try — tryptophane; Pro — proline; B,: Glu + Gln — glutamic acid + glutamine; Asp + Asn — asparagic acid + asparagine; Phe + Leu + Ile — phenylalanine + leucine + isoleucine; Lys — lysine; C,: Tyr — tyrosine; Met — methionine; Cys — cysteine

Between the fourth and fifth hour a characteristic decrease of level can be observed in all amino acids examined. This phenomenon may be due to a higher rate of protein synthesis, which does not, however, sufficiently explain the decrease of level, the less so because in the next phase an increased concentration can be observed again in the case of several amino acids. It is probably a case of amino acid recomposition inhibited (Umbarger 1956, Subramanian *et al.* 1968), which is supported by the fact that the level of the majority of the free amino acids subsequently rises only to a very low extent.

After a temporary decrease the level of Glu+Gln maintains its rising character, while the Ala and Gly levels reach a plateau between the 13th and 16th hour (1.A). In the two latter cases the temporary stagnation between the 7th and 10th hour suggests a more intensive process of transamination and protein synthesis. The increasing rise of Glu+Gln levels seems to support the idea of these amino acids playing an important role in transamination and amino group storage (1.B) (Kretovich *et al.* 1959).

Tyrosine showed characteristic changes in level (1.C) similar to those in glycine, nevertheless, this rise cannot be expected in the primary amination mechanisms. The three maxima found in the methionine level (1.C) and the subsequent decrease can be considered as characteristic from the point of view of induction, nitrate reduction — due to the very decrease in the level — probably plays a subordinate role in this.

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SOWING TIME EXPERIMENTS WITH MAIZE

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The paper discusses the results of sowing time experiments carried out with the medium early Mv 40 (FAO 340) and medium late Mv 1 (FAO 600) hybrids sown into a meadow clay soil at Martonvásár, from 1958 to 1969. Sowing performed every five days did not result in a curve declining toward early sowing (April 15). In plant stands sown at a later time (May) the yield of medium late hybrids decreased earlier (May 5) than that of the medium early hybrids (May 15), on many years' average. When sown a month earlier the plants showed 14—15 days earlier maturation on many years' average.

Introduction

In Hungary as well as in several other countries the sowing time of maize has shifted lately towards earlier dates (Rossman—Cook 1966, Aldrich—Leng 1966). This change in the sowing time was caused by hybrids with longer vegetative periods introduced in the production on one hand, and improvement in the conditions of earlier sowing (good hybrid seed, dressing, soil disinfection) on the other. In order to determine the right time of sowing, experiments were conducted at Martonvásár over more than one decade with two hybrids: the medium early Mv 40 (FAO number: 340), and the medium late Mv 1 (FAO number: 600). Results of these experiments were published in yearly details (I'só 1962, 1966, 1969). In connection with the experiments ontogenetic studies were also carried out (I'só—Szalay 1966, 1969). The present paper gives a brief summary of the results of more than ten years' experiments.

Material and Method

We performed our experiments between 1958 and 1969 in the experimental farm of the Institute at Martonvásár in a chernozomic loam soil. The major analytical data on the soil of the experiments: $CaCO_3 = 1.1\%$, $pH = 7.6$, $hy = 3.4$, $humus = 4.5\%$ and ground water level = 1.5—2 m. Data on the weather conditions are presented in Table 1.

The experiments were given each year treatments of the same sowing dates, with identical patterns and methods. The two hybrids mentioned in the introduction were studied with 8 sowing times, split-plot design and 4 replications applied. In 1958 and 1959 experiments were performed only with the hybrid Mv 5 (FAO number: 420). The hybrid Mv 1 being susceptible

Table 1

Meteorological data
Martonvásár, 1958–1969

Year	Months							
	Oct.–March	April	May	June	July	August	Sept.	
Precipitation mm								Total
1958	210	27	23	180	67	38	18	353
1959	207	58	83	100	89	6	28	364
1960	229	45	30	64	112	34	62	347
1961	342	72	69	58	52	8	2	241
1962	271	39	38	22	48	2	31	180
1963	381	33	39	98	64	66	92	392
1964	162	37	32	145	55	68	24	361
1965	307	67	73	179	78	88	83	568
1966	326	49	59	53	159	87	10	417
1967	288	60	85	54	62	25	89	375
1968	108	39	30	29	48	165	53	364
1969	319	8	47	110	45	75	36	322
Average (1901–40)	243	46	66	62	50	52	52	328
Temperature °C								Yearly average
1958	3.3	9.0	20.1	18.4	21.7	21.3	16.3	17.8
1959	4.5	11.4	16.0	18.9	22.8	20.8	15.0	17.5
1960	3.7	10.6	15.7	21.0	20.1	21.3	15.2	17.3
1961	5.4	14.0	14.9	20.2	20.0	20.4	17.9	17.9
1962	3.5	12.7	14.9	18.3	20.0	23.0	16.0	17.5
1963	1.2	12.0	15.9	19.7	22.2	21.7	18.0	18.2
1964	3.0	11.9	15.7	22.1	21.2	18.8	15.8	17.6
1965	3.6	9.3	14.4	19.0	20.1	18.7	16.5	16.3
1966	4.2	13.3	17.2	20.4	21.0	20.4	16.8	18.2
1967	4.8	11.5	17.6	20.1	24.1	21.4	18.1	18.8
1968	4.2	13.4	17.9	22.2	22.0	20.2	16.3	18.7
1969	2.8	11.3	19.6	19.6	22.2	19.7	17.0	18.2
Average (1901–40)	3.1	10.1	15.9	19.1	21.5	20.7	15.7	17.1

to fusarium that had occurred in 1966 was replaced in 1967 and 1969 by Mv 602 (FAO number: 602) which has a similar vegetative period but is more resistant to fusarium.

The size of the main plots (sowing time) was 25 m^2, that of the sub-plots (hybrids) 12.5 m^2, with 100 and 50 plants per plot respectively with border- and buffer rows not taken into consideration. Plant population was 40 thousand/ha (50 × 50 cm) with both hybrids. No plant number correction was applied to the results of the experiment. The dry grain yield (15%) was determined on the basis of 5 kg cob corn per sub-plot, in 4 replications. When determining maturity a 35 percent moisture content of the grains was taken for basis.

Table 2

Relative numbers of yield results in sowing time experiments
Martonvásár, 1958–1969

Year	Hybrid	IV. 15.	IV. 20.	IV. 25.	IV. 30.	V. 5.	V. 10.	V. 15.	V. 20.	S. d. 5%
1958	Mv 5 (FAO 420)	100	104	94	105	112	104	115	114	23
1959	,,	100	99	99	96	95	91	80	71	11
1960	Mv 40 (FAO 340)	100	102	95	112	95	99	104	96	9
1961	,,	100	91	98	82	91	90	95	94	11
1962	,,	100	101	105	96	101	95	89	93	15
1963	,,	100	96	90	94	100	100	98	97	16
1964	,,	100	98	100	98	99	100	92	84	10
1965	,,	100	99	95	92	97	105	88	93	6
1966	,,	100	108	107	111	97	101	100	88	9
1967	,,	100	100	101	98	105	100	98	72	6
1968	,,	100	99	96	94	91	93	84	77	8
1969	,,	100	98	100	108	105	98	95	97	5
10-year-average		100	99	99	98	98	98	94	89	—
12-year-average		100	99	98	99	99	98	95	90	—
1960	Mv 1 (FAO 600)	100	99	102	105	104	114	99	77	9
1961	,,	100	91	95	98	99	85	84	83	11
1962	,,	100	96	99	93	90	73	77	75	15
1963	,,	100	104	96	92	120	105	106	109	16
1964	,,	100	97	98	85	94	99	80	78	10
1965	,,	100	97	95	98	91	93	87	85	6
1966	,,	100	97	100	92	94	93	88	75	9
1967	Mv 602 (FAO 602)	100	99	96	100	100	87	82	79	6
1968	,,	100	101	104	93	92	88	82	81	8
1969	,,	100	97	100	97	98	97	92	85	5
10-year-average		100	98	98	95	97	93	88	83	—

Results

The relative numbers of crop results in the experiments are shown by Table 2. As to the effect of the sowing time there are considerable differences between the results of the individual years. It is enough to refer here to the contrasting results of the two successive years: 1958 and 1959. While in 1958

Table 3

Number of days between sowing and sprouting in the sowing time experiments
Martonvásár, 1958—1969

Variety Year	Air temperature C°		Sowing time							
	April	May	IV. 15.	IV. 20.	IV. 25.	IV. 30.	V. 5.	V. 10.	V. 15.	V. 20.
Mv 5										
1958	9.0	20.1	21	18	15	13	11	10	9	10
1959	11.4	16.0	20	18	14	11	9	9	8	10
Mv 1										
1960	10.6	15.7	25	24	20	15	11	8	6	8
1961	14.0	14.9	12	13	12	10	11	13	11	9
1962	12.7	14.9	8	15	17	15	15	14	13	10
1963	12.0	15.9	12	11	10	11	11	8	10	9
1964	11.9	15.7	16	18	15	12	10	8	11	9
1965	9.3	14.4	25	25	22	19	15	11	9	11
1966	13.3	17.0	14	12	9	8	10	8	6	10
Mv 602										
1967	11.5	17.6	23	19	15	11	10	9	12	13
1968	13.4	17.9	13	10	12	10	8	8	11	10
1969	11.3	19.6	17	13	9	11	12	9	9	10
Mean*	10.1	15.9	16.5	16.0	14.1	12.2	11.3	9.6	9.8	9.9
Max.	14.0	20.1	25	25	22	19	15	14	13	13
Min.	9.0	14.4	8	10	9	8	8	8	6	8
Diff.	5.0	5.7	17	15	13	11	7	6	7	5
Mv 40										
1960	10.6	15.7	23	23	18	14	10	7	6	8
1961	14.0	14.9	12	13	11	9	10	12	11	9
1962	12.7	14.9	8	15	17	15	15	14	13	10
1963	12.0	15.9	11	10	9	10	10	7	9	8
1964	11.9	15.7	15	17	14	11	9	7	10	8
1965	9.3	14.4	24	24	21	18	14	10	8	10
1966	13.3	17.0	13	11	8	7	9	7	5	8
1967	11.5	17.6	23	19	15	11	9	10	11	12
1968	13.4	17.9	12	10	11	9	7	7	10	9
1969	11.3	19.6	16	12	8	10	11	8	8	9
Mean	10.1	15.9	15.7	15.4	13.2	11.4	10.4	8.9	9.1	9.1
Max.	14.0	19.6	24	24	21	18	15	14	13	12
Min.	9.3	14.4	8	10	8	7	7	7	5	8
Diff.	4.7	5.2	16	14	13	11	8	7	8	4

* Air temperatures mean refers to the years between 1901 and 1940, while the number of days to those between 1960 and 1969.

Table 4

Number of days from sowing to ripening in the sowing time experiments
Martonvásár, 1960—1969

Year	Variety	Date of sowing							
		IV. 15.	IV. 20.	IV. 25.	IV. 30.	V. 5.	V. 10.	V. 15.	V. 20.
		number of days from sowing to ripening							
1960	*Mv 1.*	183	178	175	172	169	165	161	158
1961		162	157	154	152	153	152	149	145
1962		173	172	172	168	166	162	163	159
1963		163	158	153	165	157	152	154	149
1964		157	158	157	153	150	148	146	144
1965		171	167	163	160	157	154	151	148
1966		157	153	149	153	157	153	150	147
1967	*Mv 602*	167	162	158	154	153	152	152	152
1968		165	162	159	156	153	152	152	152
1969		173	170	168	168	168	166	164	162
Mean		167	164	161	160	158	156	154	152
Maximum		183	178	175	172	169	166	164	162
Minimum		157	153	149	152	150	148	146	144
Diff. (Max.—Min.)		26	25	26	20	19	18	18	18
1960	*Mv 40*	158	153	150	148	145	142	138	135
1961		153	148	145	142	139	139	139	137
1962		166	163	163	158	157	152	151	147
1963		136	137	132	135	137	132	133	128
1964		144	137	134	132	130	126	122	120
1965		162	158	154	149	144	141	138	135
1966		153	139	135	135	135	137	140	142
1967		152	149	146	141	137	136	135	134
1968		143	138	134	135	136	137	138	139
1969		153	148	144	143	141	141	142	143
Mean		152	147	144	142	140	138	138	136
Maximum		166	163	163	158	157	152	151	147
Minimum		143	137	132	132	130	126	122	120
Diff. (Max.—Min.)		23	26	31	26	27	26	29	27

maize produced higher yields when sown in May, it gave better results in 1959 when sown in the middle of April. Neither hybrids with different vegetative periods showed similar trends when sown in May. On the average of ten years the yield of the medium late hybrid Mv 1 (FAO 603) decreased considerably already from the 5—10th May on, while with the medium early Mv 40 (FAO 340) significant decrease in the yield occurred only on 15—20th May. With the earliest time of sowing (15 April) yields did not decrease in either of the hybrids on ten years' average. Between the two hybrids there was a ten-year average of 13 percent difference in yield in favour of the medium late hybrids. With plants sown later these yield differences generally decreased as compared to those sown early.

Table 3 presents the number of days between sowing and emergence, both in a yearly distribution and ten years' average. Maximum and minimum data of many years are useful in giving information about cultural practices relative to the emergence of plants. Differences between the maximum and minimum data — like those between the averages — decrease with plants sown later. Monthly averages of air temperature included in the tables are not suitable to point out close correlations. They are presented only to show that temperatures in April — and mostly in May too — during the experimental years were higher than the 40-year average.

Thus, earlier sowing was found to promote ripening in both hybrids even within the limits of the main time of sowing (15 April—15 May), where in the case of the early hybrids no yield difference could be found on the average of ten years. This accelerating effect of earlier sowing is very important from the point of view of harvesting. Medium late hybrids (of 600 FAO number) when sown a month earlier (15 April—15 May) ripen at the same time as medium early hybrids would ripen (FAO 300) if sown in the middle of May (Table 4).

Conclusions

Under normal weather conditions in Hungary maize is best sown in the second half of April. Although on the average of ten years the amount of yield does not considerably change between 15 April and 5 May with the medium late hybrids (FAO 600) and between 15 April and 15 May with the medium early hybrids (FAO 300), the experimentally proved earlier ripening of maize sown at an earlier date (15 April) means a great advantage when harvesting. Towards the earliest date of sowing (15 April) the declining end of the yield curve has not been reached yet. However, on the average of 6 years experiments not discussed here, sowing at an earlier date than 15 April resulted neither in higher yields nor in earlier ripening (I'só 1969).

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STUDIES ON ABNORMAL GROWTH IN PLANTS

I. ANATOMY OF INSECT — INDUCED TUMORS ON THE VEGETATIVE PARTS OF PROSOPIS SPICIGERA L.

By

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The infection of the lamina and rachis of *Prosopis spicigera* L. by insects occurs in the earlier developmental stages of the organs, which are tender at these stages. The leaf galls are formed due to the hypertrophy and hyperplasia of mesophyll tissue and medullary cells. The formation of cavities in laminar galls is schizogenous. The rachial galls develop due to the activity of a cork cambium, together with the origin of a lysigenous cavity. The production of cork cambium in this case is considered to be influenced by the production of certain hormones produced due to the injury of central cells. The production of galls is beneficial only to the pathogen and not to the host. It is suggested that the usage of suitable insecticides will go a long way in the control of these tumors.

Introduction

The anatomy and mechanism of tumor formation in plants due to insects have been studied by a number of workers (MEDLER 1941, GLASS 1944, KOMAREK 1946, HOUGH 1954, WEIDNER 1957). MEDLER (1941) reported the formation of hypertrophied cells characterized by nuclear enlargement in plant tumors. KOMAREK (1946) described the formation of cork tissue and other secondary tissues in ash trees infected with insects. MANI (1964) also gave an account of the histology of tumors caused by various insects on plants.

The present study is a contribution to the developmental anatomy of foliar galls produced by the infection of *Eriophyes prosopidis* Saksena and rachial galls induced by an unknown chalcid insect (cf. MANI 1964) on *Prosopis spicigera* L., a common tree grown on semi-arid regions of India.

Material and Method

The material used for the present study was collected at Hissar and includes the normal plant parts of *Prosopis specigera* and galls produced on them. Leaf galls were collected in April, May and June and rachial galls in May and June at Hissar (India). The material collected at different stages of development was fixed in F.A.A., dehydrated and embedded in paraffin by means of the customary method using xylene as clearing agent. 8—15 μ thick longitudinal and cross-sections of the normal organs and galls were cut. The sections were stained with safranin-fast green combination by the usual method (JOHANSON 1940). In addition, leaves were cleared by using Foster's technique (FOSTER 1946) to learn the position of galls in relation to veins.

Results

Foliar galls. The foliar galls on *Prosopis spicigera* induced by *Eriophyes Prosopidis* Saksena appear in the first week of April, third week of June and at the beginning of October. The galls are of greenish colour and show varying shapes and dimensions. The number of galls on a leaf may vary from one to

Fig. 1. Leaf clearing showing the development of galls. ×167

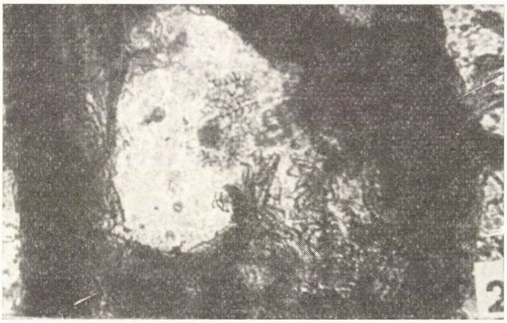

Fig. 2. Leaf clearing showing the development of galls. ×167

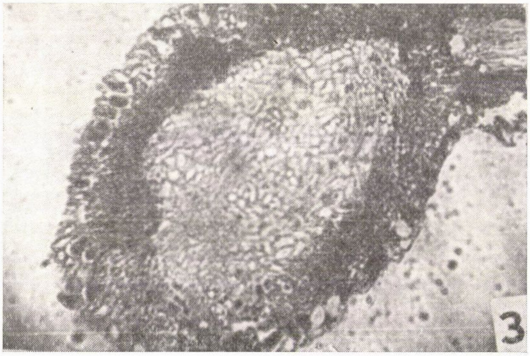

Fig. 3. Transection of a gall at the margin of leaf. ×167

twenty and may be formed on leaf lamina or on the midrib. It has been noted that the galls have a definite relation to midrib or a subsidiary vein without exception, at least one vein being involved in the formation of a gall (Figs 1, 2). Instances where the entire leaf has converted into galls are also not rare.

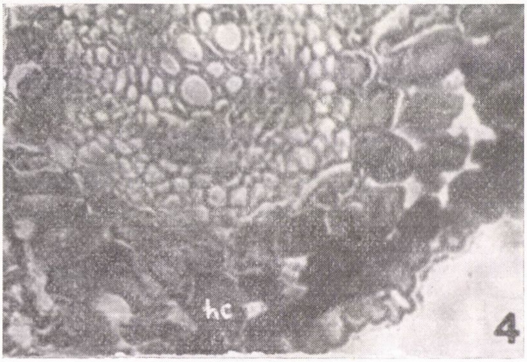

Fig. 4. Developmental stages of leaf galls. (hc = hypertrophied cell) ×621

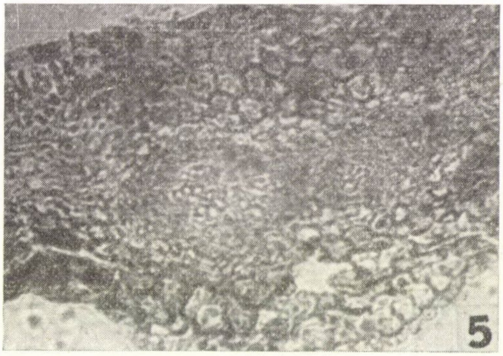

Fig. 5. Developmental stages of leaf galls. ×167

Fig. 6. Development of larval cavities in the foliar gall. (l = locule) ×167

A comparative study has been performed between the structure of a normal leaf and the galls. The cross-section of a normal leaf shows a unilayered epidermis consisting of cells with a dark substance, probably tannin content. The stomata are present on both sides of the leaf and are sunken in depressions formed by the elevated and colourless subsidiary cells. The palisade tissue is present on both sides. On the dorsal side, the palisade is normally one or rarely two- layered, while on the ventral side its number varies from two to three. Some leaves lack a palisade tissue on their dorsal side. The palisade parenchyma may or may not be present at the portion of the bundle and in the latter case their place may be occupied by more or less compactly arranged mesophilous parenchyma. The leaves show the characteristic bifacial arrangement of the xylem which is arc-shaped, with the protoxylem facing towards the ventral side and the metaxylem towards the dorsal side. A few layers of parenchymatous cells are present between the arm of the xylem. An incomplete bundle sheath composed of thick walled cells which is further enveloped by a single layer of thin walled parenchymatous cells with or without greyish contents is found on either face of the bundle.

The leaf galls may be either bifacial or radial. The former is formed by the activity of cells on one face of the leaf only and the latter by their equal activity on both faces. In either case the vascular bundle expands on the lateral sides by the rapid divisions and enlargement of parenchymatous cells between the arms of the xylem tissue. Cells of the mesophyll tissue in the region of the veins where the galls develop become hypertrophied and possess greyish contents (Figs 3—5). The cells become irregular in shape and the cell walls become unevenly thick. The thickness of the inner bundle sheath gets reduced. The cells of both this and the outer tissue undergo rapid divisions to give rise to 4—5 layers of cells (Figs 4, 5). The epidermal cells on either side attain radial elongation. The xylem parenchyma between the vessels also undergo divisions but at a slow rate.

The epidermal cells at some places undergo rapid division, most of the cells contain tannin (Fig. 3) and the cell-walls show a striated appearance. It is also noted that the epidermal cells normally enlarge two to three times the original size in a radial direction. The mesophyll cells below the epidermis undergo rapid division both in a longitudinal and a transverse direction, forming a compactly arranged tissue composed of 3—6 layers of cells (Fig. 5). The cells of mesophyll are filled with a dark content, probably tannin (Fig. 6).

Below these tissues, there are groups of prosenchymatous cells which form a discontinuous rose coloured layer, when stained with safaranin. In some leaf galls, thick walled cells present on either side of the vascular bundles are pushed apart and the individual cells show a large number of pits. The leaf gall is transversed with vascular supply on all sides at the young stage. Thus the young gall attains a radial symmetry comparable to the stem. In a transverse section the vascular bundles are arranged in a ring and the cells between the vascular and the central parenchymatous tissue enclosed inside the vascular tissue undergo both hypertrophy and hyperplasia.

A proper periderm formation was not observed but in a few instances cells resembling cork in arrangement, were observed. Their general appearance

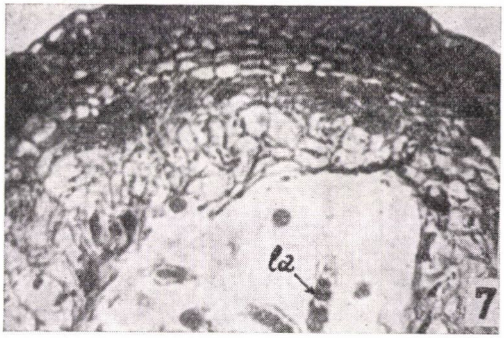

Fig. 7. Development of larval cavities in the foliar gall. (la 2 larvae) ×167

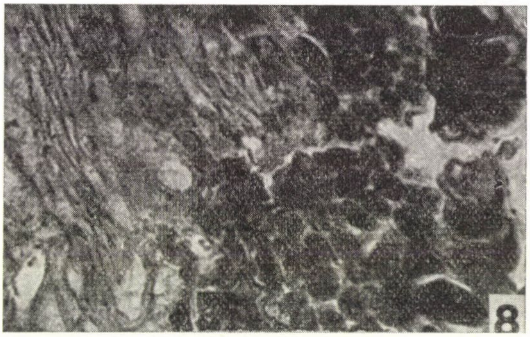

Fig. 8. Preliminary stage in the development of ostiole. ×621

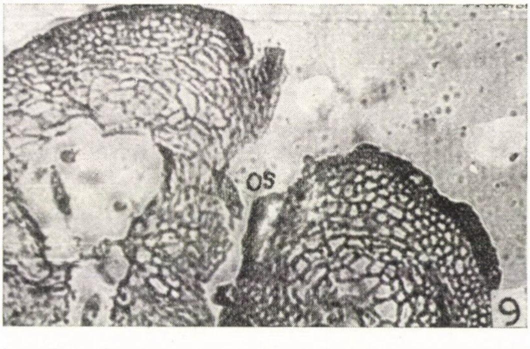

Fig. 9. Larval cavity together with the ostiole. (os = ostiole) ×127

suggests formation from the regular division of parenchymatous cells outside the vascular bundles rather than from a phellogen (Fig. 7).

The central parenchymatous cells enlarge considerably perhaps due to hyperplasy. The subsequent enlargement causes production of cavities due to the separation of cells from each other and the disintegration of some of the cells at a later stage (Figs 6, 7). The enlargement of galls is accompanied by an increase in the number of cavities. The dissolution of the septa between the cavities gives a lobed configuration to the latter (Fig. 7). Each cavity opens to the exterior by a narrow ostiole. Both larvae and eggs were observed in these cavities. In a mature gall the epidermal cells get laterally extended due to the enormous enlargement of the galls and the contents show a striated appearance. The tissue below the epidermis has two distinct regions: an outer region consisting of a few layers and an inner region composed of compactly arranged cells. The central cavity, separated by parenchymatous septa is occupied by larvae.

Each leaf gall has an ostiole which opens outside. Ostiole initiates below one of the stomatal apertures and at the region where it develops, the mesophyll cells undergo rapid division (Fig. 8). The ostiole is narrow in the middle and wide at both sides and surrounded by narrow elongated cells (Fig. 9).

The number of galls in a leaf in a single transverse row (breadthwise) may vary from one to several. These galls may remain separate (Fig. 10) or may fuse by the lateral sides to form a composite gall. Normally in a composite gall the structure of the individual gall remains the same, the two adjacent galls being separated by parenchymatous cells with a dark substance. The septa are developed from the epidermis as well as the mesophyll of the leaf. The ostioles are independent in each component of the composite gall. Instances where the whole leaf is converted into a gall are not rare.

The structure of the gall formed at the apex of the leaf is very different from those formed at the laminar portion (Fig. 11). These galls are more or less globular. A number of cavities are arranged around a common centre while the central region itself develops a schizogeneous cavity with radiating arms. Each arm of this central cavity is normally alternate with the outer cavities. A clear radial symmetry is an outstanding feature in such galls. Scleriform cells are present in separate groups on the peripheral region and also around the central part and the schizogeneous cavity in the centre is surrounded by a well defined epithelium.

Rachial gall. The rachial galls are initiated at the middle of May and at the beginning of October. In comparison with the leaf galls the galls on the petiole are hard and dull brown in colour and are normally oblong, globular or pipette shaped. The petiole galls mature in the last week of June. The formation of rachial galls is reduced to a minimum at the beginning of July.

In a normal petiole the epidermis consists of a single layer of cells. The cortical layer is comprised of a tanniniferous outer tissue (2), one or two layers of parenchymatous cells (3), sclerenchymatous tissue consisting of 2—3 layers of cells deeply stained with safranin and (4) one or two layers of parenchymatous cells. Phloem is present in the form of a ring round the xylem tissue. The vascular tissue is endarch. The pit consists of thin walled parenchymatous cells with a few interspersed sclerenchymatous cells (Fig. 12).

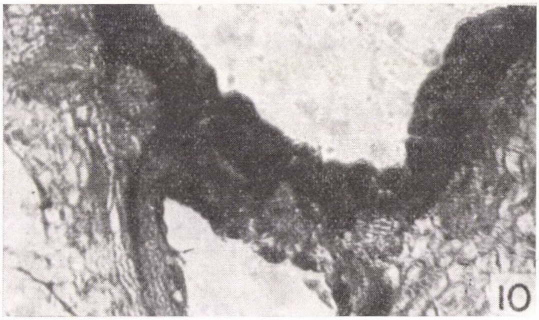

Fig. 10. Two galls from a single leaf. ×127

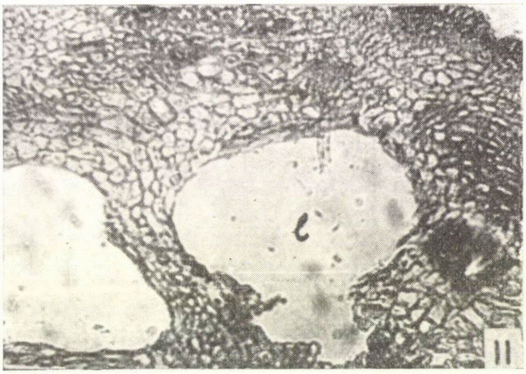

Fig. 11. Transection of the gall at the tip of the leaf. (l = locule) ×127

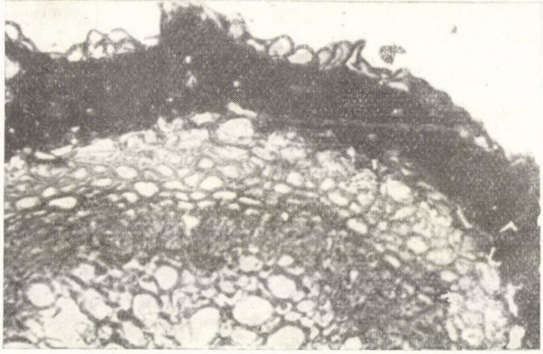

Fig. 12. Transection of a normal rachis. ×127

During the gall formation, the parenchymatous cells of the cortex below the tanniniferous layer enlarge and divide to form a number of layers composed of parenchymatous cells. Out of these, the cells one or two layers below the outer tissue get converted into phellogen. The cells of the phellogen cut off one or two layers of phellem outside and a layer of phelloderm inside (Figs 13, 14). The thick walled cells are mainly converted into stone cells and get dispersed in the parenchymatous tissue (Fig. 15). The parenchymatous cells of the pith

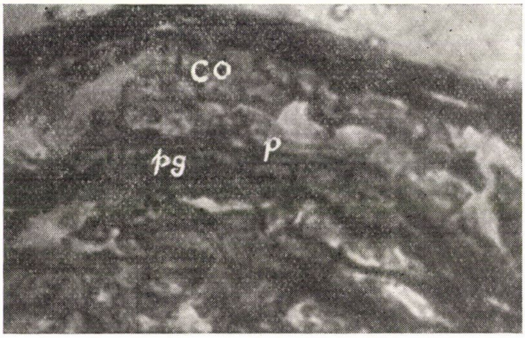

Fig. 13. The stages in the secondary growth of infected petiole. (co = cork; p = phellem; pg = phellogen) ×621

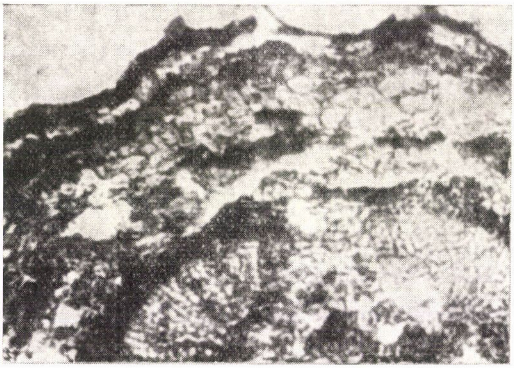

Fig. 14. The stages in the secondary growth of infected petiole. ×127

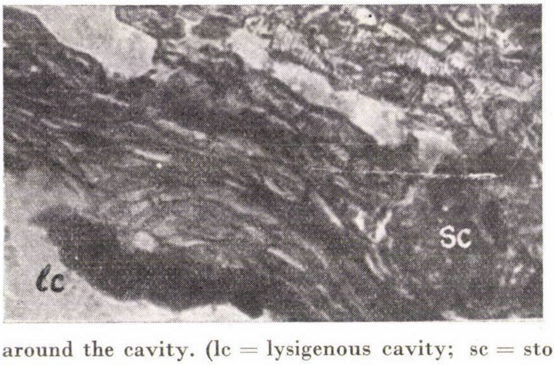

Fig. 15. Tissue around the cavity. (lc = lysigenous cavity; sc = stone cells) ×621

enlarge considerably and divide at a rapid rate. The xylem parenchyma between the vessels get divided mostly in a radial direction. The inner walls of cells adjacent to phelloderm are suberised. The rapid inflamatory growth of the gall results in the production of lenticels due to the breaking of the epidermis. However, there is no cork cambium beneath the lenticel.

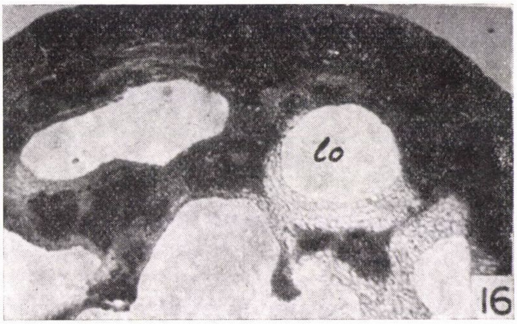

Fig. 16. Multilocular petiolar gall with accumulation of tannin like substance in cells (lo = locule) ×127

Normally a single central cavity is formed in the petiole gall due to the disintegration of the medullary region. The parenchymatous cells around the cavity undergo rapid periclinal divisions giving rise to laterally elongated cells arranged in regular layers which form a boundary to the central cavity. At maturity the galls open outside by means of an ostiole.

Presence of multilocular rachial galls is not uncommon in *Prosopis* (Fig. 16). In one of such galls one small and two larger cavities were noted. At the upper portion the amalgamation of one of the cavities with an other gave rise to a bilocular condition, each locule having a lobed appearance. One of the cavities opened first by an ostiole with zig-zag margin. The outline of the cavity suggested their schizogenous origin, although the exact development could not be studied. Periderm was not found in the above gall. The subepidermal cortex was 2—4 layered and was filled with tannin. The vascular tissue was found to traverse below this tissue. Inside the vascular tissue was the ground tissue mostly formed by cells with granular contents followed by the innermost layer of parenchymatous cells. The cavity was delimited by regularly arranged parenchymatous cells which form an "epithelium" like layer.

Discussion

The tumorous growth in the lamina is caused by *Eriophyes prosopidis* while the casual organism that induces the abnormal growth in the rachis is an unknown Chalcid insect (Mani 1964). The growth pattern that follows after infection in these two organs is considerably different. The formation of galls in the lamina is due to the hypertrophied growth of the mesophyllous cells followed by their rapid rate of division accompanied by the formation of schizogenously formed air spaces, in which the larvae pass their stages of development. The change in the symmetry of the bundle from a bifacial to a radial one is an interesting feature in the development of laminar galls, which probably suggests the potentiality of the leaf for expressing cauline characteristics at least in special situations.

The formation of rachial galls is distinct from that of the laminar ones. In the former the enlargement is partly due to the activity of the cork cambium which functions for a short while resulting in the production of a small amount of periderm. The rachial gall moreover is "unilocular" and the cavity is lysigenous in origin. The surface of the rachial galls is rough, due to the production of a cork.

It will be recalled here that the production of cork cambium in the rachial gall which is responsible for a secondary growth in this organ is a feature developed under the influence of the insect. It is possible that the production of phellogen is in some way connected with certain wound hormones produced due to the injury of the central tissue during the formation of lysigenous cavities in the rachis, which migrates to the outer tissues, comparable to the production of periderm in wound healing in dicots. As already pointed out the cells adjacent to the cavity in the rachis undergo rapid periclinal divisions resulting in the production of a few layers of cells forming an epithelium like tissue. The division of cells most probably is influenced by the wound hormones produced by the breaking of the cells in the medullary region. However, such a conclusion requires further investigation including the physiological and biochemical aspects of gall formation.

It seems that the formation of galls in *Prosopis* is in no way beneficial to the plant but it benefits the casual organism in two ways namely by giving a locus to complete its life cycle and by providing nourishment during the development.

It is not known so far whether the production of the gall is due to certain secretions by the insects or due to the growth stimulating substances produced by the plant tissues as a defence mechanism. Elaborate investigation in this direction will be beneficial for understanding the mechanism of tumor formation. At the same time a possible means of checking the gall formation in the plant may be suggested by spraying it with suitable insecticides during the initial stage of insect infection i.e. at the beginning of April, June and October in case of foliar galls, and at the middle of May or the beginning of October in case of rachial galls. A study in this direction is in progress.

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EFFECT OF TIME AND DEPTH OF NITROGEN APPLICATION ON GROWTH AND YIELD OF RICE

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The nitrogen requirement of the rice plant has a continuous character. Deep placement of nitrogen, beside its preventing effect on the loss of nitrogen from waterlogged-soil following Pearsall-Mitsui mechanism, also satisfies the nitrogen requirement of the rice plant in its later phase of growth. A 20—25% increase in yield was obtained as compared to the surface shallow placement method.

Introduction

In recent years, the nutritional physiology of the rice plant has been studied in detail (MITSUI 1960, TANAKA 1961, OSHIMA 1962, ISHIZUKA 1963). Knowledge on the nutrient requirement of rice at different phases of growth and development has considerably contributed to the elaboration of efficient methods of nitrogen application in the rice growing practice.

As several authors have reported (PEARSALL 1950, RAMIAH *et al.* 1951, MENON 1957, ABICHANDANI—PATNAIK 1958, PRETTENHOFFER 1959, MITSUI 1960) deep placement of ammonium sulphate for rice is an effective method for preventing the loss of nitrogen in waterlogged soil. The large increase in rice yield obtained by this method directs the attention of plant physiologists to this problem. This paper summarizes our investigations on the nitrogen nutrition of the rice plant in connection with the physiological effects of nitrogen deep placement.

Material and Method

Field experiments were carried out on 40 m^2 plots in four fold replications, using standard rice growing techniques. Before transplantation, superphosphate and potassium chloride were applied at the rate of 40 kg/ha of P_2O_5 and 40 kg/ha of K_2O. For deep placement, ammonium sulphate was mixed with ordinary soil at the ratio of 1 : 10. The appropriate amount of water was added, and ball fertilizers of 15—20 g weight were prepared from this mixture. The balls were allowed to dry and then applied in the rice field by inserting them in the middle of four hills, at the rate of 60 kg N/ha, within one week after transplantation. In the control plot, ammonium sulphate in powder form was applied as basic application on the surface one day before transplantation. Plots were weeded with rotatory weeders or by hand. Insecticide (666) was applied twice at the rate of 30 kg/ha to prevent the attack of stem borer. After transplantation, the field was kept flooded until the ripening stage.

Pots with dimensions of 20 × 20 × 20 cm were used in greenhouse experiments. Each contained 15 kg soil obtained from furrow slice of paddy fields of the Van dien Experiment Station. Superphosphate and potassium chloride were applied before transplantation at the rate of 0.1 g P_2O_5 and 0.1 g K_2O per kg dry soil. Nitrogen was applied at various depths as ball fertilizer or concentrated layers were formed from the fertilizer at the rate of 0.2 g per kg dry soil.

Water culture experiments were carried out in pots of the same size, using Kasugai solution as a nutritional medium (NAGAI 1958).

Photosynthetic activity of the whole plant was measured by a titration method (POTSINOK 1960) at 30° C and 6000 lux. Nitrogen content was determined by the Kjeldahl method.

Results and Discussion

Nitrogen absorption and the effect on rice yield of nitrogen shortage at different growth phases were studied in greenhouse experiments in water culture, and soil culture. Rice varieties grown in North Vietnam in different agricultural seasons (spring-crop, autumn-crop, summer-autumn crop) were used. A summary of these experiments is given in Tables 1 and 2.

The rice plant absorbs most of its nitrogen in the tillering and ear formation stage. This is in line with earlier works (TOGARI—MATSUO 1962, TANAKA *et al.* 1964, REYES *et al.* 1962).

Details about the effect of nitrogen dressing at different times within the tillering stage are given in Table 3. Tiller number increased rapidly if the whole amount of nitrogen was applied at the beginning of the tillering stage (7 days after transplantation). However, the number of tillers deteriorated at the end of the tillering stage was also high and this resulted in a low number of panicles. Best results were attained with the same amount of nitrogen by dividing the fertilizer into two parts, one applied at the beginning and the other at the end of the tillering stage. As shown in Table 3, this favourable effect was due to an increase in panicle number. It is clear that under normal conditions, the rice plant requires a certain amount of nitrogen at the end of the tillering stage to enable its preformed tillers to develop fully and to become effective. As reported by several authors (BABA 1954, ISHIZUKA—TANAKA 1963) the

Table 1

Nitrogen absorption by the rice plant in various phases of growth

	Phase			
	Seedling	Tillering	Ear formation	Ripening
Absolute amount absorbed (mg N/plant)	37.4	86.2	155.1	25.3
(%)	12.3	28.3	51.0	8.3
Absorption rate (mg N/plant/day)	0.7	4.3	3.9	0.7

nitrogen absorption capacity of the root system of rice in the tillering stage is very high. A single application of a large amount of readily available nitrogen at the beginning of this stage certainly leads to an excess of nitrogen absorption. Especially, as reported by Oka (OKA 1956), the indica rice varieties absorb

Table 2

Effect of nitrogen shortage on rice yield in various phases of growth

Experiment conditions	Phase		
	Seedling	Tillering	Ear formation
Spring crop (water culture)			
Control	100.0*	100.0	100.0
N shortage	63.5	0.0	42.7
Autumn crop (soil culture)			
Control	100.0	100.0	100.0
N shortage	82.3	73.7	90.0
Summer-autumn crop (soil culture)			
Control	100.0	100.0	100.0
N shortage	93.2	75.2	84.2

* Yield expressed on a percentage basis

Table 3

The effect of nitrogen application at different times within the tillering stage on rice yield and growth

Treatment	Grain yield kg/ha	%	Panicle /m²	Mean tillering rate* tiller/m²	Mean deteriorating rate** tiller/m²
Control	2820 ± 72	100	266	27.6	10.8
30 kg N/ha, beginning of TS***	3090 ± 55	109	274	37.2	14.4
15 kg N/ha, beginning of TS+	3260 ± 61	116	324	33.0	6.0
15 kg N/ha, middle of TS+					
15 kg N/ha, beginning of TS	3420 ± 80	121	324	33.0	6.0
15 kg N/ha, end of TS					

* number of new tillers per m² in 3 day intervals

** number of deteriorated tillers at the end of the tillering stage per m² in 3-day intervals

*** TS: tillering stage

nitrogen much more intensively than the japonica varieties. Table 4 illustrates the results of one of our experiments pertaining to this problem.

Details about the effect of nitrogen dressing at different times within the ear formation stage are given in Table 5.

As confirmed by this experiment, as well as by those mentioned above, the nitrogen requirement of the rice plant has a "continuous" character.

Table 4

*Nitrogen absorption capacity of different rice varieties**

Varieties	mg/plant/day		
	Phase of growth		
	Seedling	Tillering	Ear formation
Ba zang (local variety, indica)	0.56	18.4	15.5
1088 (originated from Taiwan, japonica)	0.45	12.3	19.7

* water culture experiment

Table 5

The effect of nitrogen dressing at different times within the ear formation stage on rice yield and growth

Time of nitrogen application	Yield kg/ha	%	Panicle/ m^2	Filled grain/ panicle	100 grain weight g
Control	3000 ± 90	100	256	69	18.6
Flower differentiation	3200 ± 62	106	274	82	18.3
Flower differentiation + Meiosis	3360 ± 73	111	280	83	18.9

Table 6

The effect of different methods of nitrogen application on rice yield and growth

Treatment	Yield				Maximum tiller number (pot)	Panicle (pot)
	Straw		Grain			
	g/pot	%	g/pot	%		
Control	54	100	42 ± 0.7	100	22	17
Shallow application	124	227	69 ± 1.5	164	43	37
Mixing with soil	133	245	75 ± 1.9	178	45	37
Ball fertilizer	136	250	86 ± 1.6	203	45	42

Significant increase in rice yield was obtained by nitrogen application (in particular by leaf spraying) even after heading.

In contrast to its requirement in phosphorus and potassium the rice plant does require nitrogen in its comparatively later stages of growth as well. The high solubility of almost all common nitrogen fertilizers and the heavy absorption of nitrogen by the root system of rice in the tillering stage make it impossible for rice growers to apply the whole amount of nitrogen needed for the normal growth and development of the rice plant as a basic fertilizer. The division into several portions of the necessary amount of nitrogen and its repeated application in powder form on the soil surface, are labor- and time-consuming procedures. In addition, this application method results in the loss of a great amount of nitrogen in molecular form, as reported by the Pearsall and Mitsui schools (PEARSALL 1950, MITSUI 1960).

Table 7

The effect of different methods of nitrogen application on the nitrogen absorption of the rice plant

Treatment	N%		% of nitrogen utilized*
	Grain	Straw	
Control	0.90	0.30	—
Shallow application . . .	1.02	0.40	41.3
Mixing with soil	1.10	0.57	64.8
Ball fertilizer	1.26	0.73	95.3

* compared with the amount of nitrogen applied

Table 8

*The effect of nitrogen applied as layers at different depths on the growth and yield of the rice plant**

Treatment cm	Grain yield	Leaf area cm^2/pot	N content %	Photosynthesis rate mg CO^2/hour/pot
0	33.2 ± 0.8	6 330	1.0	8.7
5	36.2 ± 1.2	8 810	1.4	9.2
10	39.2 ± 1.8	10 800	1.8	11.4
15	43.3 ± 0.9	10 650	2.1	10.8

* Measurements were carried out 5 days before heading

Due to these difficulties, the idea of applying nitrogen deep, in ball form, came into existence independently in several countries, where intensive land management customs were practised. Well before the publication of the work of Pearsall and Mitsui, without any connection with the Japanese agricultural experience, Vietnamese peasants practised the ball fertilizer technique in many regions. Old men and children were charged with the production of ball fertilizer from ammonium sulphate powder and ordinary soil. 10 to 15 days after transplantation these balls were inserted in the middle of each group of four hills, exactly as described by Mitsui in Japan (MITSUI 1960). The high efficiency of this method made it become widespread within a very short time.

Table 9

The effect of different methods of nitrogen application on rice yield
(Field experiment)

Treatment	Yield kg/ha	%	Panicle m^2	Grain/ panicle	1000 grain weight, g
Control	2175 ± 70	100	280	71	19.5
Shallow application	2630 ± 130	121	313	84	19.8
Mixing by using weeder	2770 ± 85	128	316	85	19.4
Ball fertilizer	3020 ± 90	139	320	89	20.0

Table 6 and 7 show the results of a greenhouse experiment on the effect of different methods of nitrogen application on growth, yield and nitrogen absorption of the rice plant. In Table 8, results of a similar experiment in which ammonium sulphate was layered at different depths are presented.

The highest yield was obtained when nitrogen was applied at the deepest layer. The favourable effect of deep placement of nitrogen can be explained by the increased leaf area, increased nitrogen content of the leaf tissue and increased photosynthetic activity during heading. Similar results obtained in field experiments, in which the mixing of ammonium sulphate was performed by using a rotatory weeder are illustrated in Table 9.

In India, MENON (1957) reported a 40 per cent increase in rice yield as a result of nitrogen deep placement. In Hungary, Prettenhoffer (PRETTENHOFFER 1959) concluded that up to a depth of 15 cm, the deeper the application of ammonium sulphate, the higher the yield. Similar results were reported in the United States (MIKKELSEN—FINFROCK 1957) and Japan (MITSUI 1960), too.

Deep placement gives rise to a long lasting effect of nitrogen that is favourable for the photosynthetic activity and dry matter accumulation of the rice plant, in its later phase of growth. The important contribution of photosynthesis after heading has been emphasized already in earlier works (SUDZUKI 1958, TENG 1963).

As far as we know, no attempt has been made to mechanize nitrogen ball fertilizer production and application. Some types of slowly available nitrogen fertilizer have been suggested. Another method is to insert ammonium sulphate powder in a deep soil layer by applying it before the last harrowing and then to flood the field as soon as possible (Mitsui 1956, Prettenhoffer 1959). Elaborating a suitable method of nitrogen application which adequately satisfies the nitrogen requirement of the rice plant during the whole period of growth and development is very important for obtaining a high rice yield.

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CHANGES IN THE Mn UPTAKE OF RED CLOVER (TRIFOLIUM PRATENSE) AS A REACTION TO LIMING

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The effect of liming on the replaceable and active Mn-content of the soil as well as on the Mn content of red clover *(Trifolium pratense)* in relation with the quantity of hay yield was studied in pot culture and field experiments on pseudogley brown forest soil. Investigations showed a close relation between the pH-value and active Mn content of the soil as a function of lime doses. Between the Mn content and hay yield of red clover a correlation was found which could be expressed by a cubic equation; this means that both high and low Mn contents are unfavourable from the point of view of the hay yield. Optimum hay yield requires an optimum Mn content in plants and optimum active Mn content in the soil. Small lime doses are more favourable for the red clover than large ones. The effect of liming can be reliably followed by examining the active Mn content of soil.

Introduction

While discussing problems related to the liming of soils, the question of micro-nutrient supply of plants is also of great importance. Liming of soils can be carried out on an up-to-date level, and optimum yields can be obtained only when the effect of liming on the micro-nutrient supply of plants is taken nto consideration.

Soils react to liming with profound changes including the change in the pH-value of the soil and the resulting changes, e.g. the availability of micro-nutrients for plants. As a result of these effects the availability of micro-nutrients for plants changes. If the pH of the soil shifts towards the alkali zone the availability of cation micro-nutrients (e.g. Mn, Cu, Zn) decreases while that of the anions (e.g. molibdate, borate) increases, as it was established by TRUOG in 1946. In case of an acidic reaction the reverse process takes place. The pH-value of the soil is of decisive importance from the point of view of the availability and mobility of Mn. Lime dotes raising the pH-value of the soil above 7 may result in the Mn shortage of cultivated plants, as it was found — among others — by PAGE (1962). On the other hand, according to MESSING (1965) in case of acidic soils liming eliminates the toxic effect of Mn on plants, reduces the water soluble, exchangeable and active Mn-content of the soil and at the same time increases the easily reducible Mn-content. MANDAL—SINHA (1964) found that liming decreases the Mn uptake of papilionaceae and other plants.

According to **Beer** *et al.* (1966) liming decreases the water soluble, exchangeable and easily reducible Mn content in the soil and increases the not so easily reducible one.

Dijkshoorn (1962) found that by acidifying the soil artificially — decreasing the pH-value by one unit — Mn-content of plants was doubled, while under the influence of liming (by raising the pH value by one unit) it was reduced to its half. **Dionne** (1966) carried out experiments with Ladino clover and found that both the exchangeable Mn content of the soil and the Mn content of the plant was reduced by liming, as a result of an increase in the pH-value. Ladino clover reacted to liming with an increase yield which can be attributed to a decrease of Mn-content present in toxic quantity.

Quellette—Généreux (1965) observed the toxic effect of Mn in potatoes and found a close correlation between the acidity of the soil and the toxic effect of Mn. In potatoes grown under the same conditions the toxic effect of Mn was higher in light soils (sand, gravel) than in hard soils (clay). According to present authors' findings application of lime and calcium nitrate decrease the unfavourable (toxic) effect of Mn, while phosphorus and potassium fertilizers increase it. **Beer** (1968) found that liming considerably decreased the Mn content of potato, bean and silo maize, and with the increase of the pH value the readily soluble Mn content of the soil decreased. Acidic fertilizers increase while alkaline fertilizers decrease the mobility of Mn and, accordingly increase and decrease respectively the Mn content of plants too. **Tölgyesi** (1964) found a decrease in the micro-nutrient content of grasses as a reaction to liming; according to his investigations the Cu, Zn and Mn contents of plants remarkably decreased.

The enumerated data prove that soil-liming exerts a great influence on the mobility of Mn and by this determines the Mn content of plants too. It is obvious from what have been described above that overliming (liming with large doses) is unfavourable from the point of view of Mn supply of cultivated plants. The method of liming with large doses still has believers who only take its effect on the soil into consideration. Therefore, it seems to be useful to deal with the problem also from the point of view of the micro-nutrient supply of plants.

Material and Method

The type of the soil used in the experiment was pseudogley brown forest soil on Quaternary clay. Detailed analysis of the soil was performed by **Cseh—Cseh** (1968).

Changes in the pH-value and active Mn content of the soil as a reaction to liming were studied in a pot culture experiment without plants, with a six weeks maturation in three replications. 1 kg doses were taken from the soil and mixed with $CaCO_3$ of various quantities as shown by Table 1. Then pots were filled up from each 1 kg dose in such a way that soil ventilation was ensured with the placing in of glass tubes and glass pots. By means of shaking soils were brought uniformly to a volume weight of 1.4. Then each soil sample was given a moisture content equal to 60 per cent of the developed pore volume, and this was maintained by a daily supply over the whole period of maturation. Maturation lasted for six weeks and took place at room temperature.

Changes occurring under the influence of liming were studied further in small-plot field experiments. The field experiment was set at Szentgyörgyvölgy in four replications in a random block design with increasing lime doses. Plot size was: 9 × 2 m. Extreme values were represented by a lime dose corresponding with hydrolytic acidity of (60—104 q/ha), an one-eighth and an eightfold dosis respectively. Red clover was sown in the spring of 1966 without any cover crop.

The active Mn content of soils was extracted by using SCHACHTSCHABEL's (1966) sulphite method (pH = 8) and then determined by a persulphate method. Exchangeable Mn content was extracted from the soil with a $MgSO_4$ solution of 0.5 mole (1 normal) without using sulphite.

Plants were dried to ashes at 450° C; then, after solving the ashes in sulphuric acid, we determined the Mn content by the persulphate method (GYŐRI 1961).

Results

Data of the pot culture experiment (Table 1) show that active Mn content of the soil gradually decreases with the increase of lime doses, whereas the pH-value increases parallelly. Calculations prove a close correlation between the two factors giving the following results concerning the relationship between the active Mn content and the pH of the soil:

$$r = -0.985 \qquad n = 8 \qquad p = 0.1\ \%$$

$$X = \text{soil pH (KCl)},$$

$$Y = \text{active Mn}$$

$$Y' = 205.4 - 26.1\ X$$

This correlation shows that the active Mn content of the soil is in 95 per cent cases a function of the soil pH. This perfectly agrees with BEER's data (1968) according to which liming exerts an effect on the availability of Mn through the pH-value of the soil, as expressed by the author's correlation coefficient ($r = -0{,}975$) too.

Active Mn-content of the soil as dependent on the dosis of lime is characterized by the subsequent data:

$$X = \text{dosis of lime}$$

$$Y = \text{active Mn}$$

$$r = -0.874 \qquad n = 8 \qquad p = 1\ \%$$

$$Y' = 10.74 - 0.0954\ X$$

The correlation can be considered as adequate, and a 58 per cent dependence on applied lime dosis of the active Mn content of soils can be established.

Table 1

Liming experiment in culture pots

Treatment	Active Mn ppm	pH	
		H_2O	KCl
1 Control	118 ± 9.8	4.89	3.92
2 13 q/ha $CaCO_3$	102 ± 6.2	5.10	4.24
3 26 q/ha $CaCO_3$	83 ± 5.1	5.53	4.47
4 52 q/ha $CaCO_3$	56 ± 4.2	6.04	4.81
5 104 q/ha $CaCO_3$	45 ± 3.8	7.07	6.04
6 208 q/ha $CaCO_3$	30 ± 3.0	7.58	7.14
7 416 q/ha $CaCO_3$	21 ± 2.3	7.58	7.17
8 832 q/ha $CaCO_3$	13 ± 1.0	7.75	7.32

Here the correlation is thus less close than in the case of the pH. Investigations by PAGE (1962) also prove that Mn changes observed in the soil cannot be judged exclusively on the basis of soil acidity, since both biological oxidation and reduction and Mn bound in a complex form by organic compounds of the soil may play a role. It is probably because the pH-value of the soil gives a better expression of the effect of these factors that we found a better correlation between the pH-value and the active Mn content of the soil.

Results and data of field experiments are presented by Tables 2, 3 and 4.

Table 2

Changes in the available Mn content of the soil as a reaction to liming
(Samples taken on June 9, 1967)

No.	Treatment	Exchangeable Mn	Active Mn	pH KCl
		ppm		
1	Control	42 ± 4.8	129 ± 6.1	5.52
2	13 q/ha $CaCO_3$	34 ± 1.6	117 ± 4.7	5.84
3	26 q/ha $CaCO_3$	25 ± 7.2	110 ± 1.4	5.88
4	52 q/ha $CaCO_3$	22 ± 1.6	98 ± 5.0	6.12
5	104 q/ha $CaCO_3$	18 ± 1.3	85 ± 1.0	6.38
6	208 q/ha $CaCO_3$	15 ± 4.3	66 ± 11.1	6.78
7	416 q/ha $CaCO_3$	9 ± 3.2	55 ± 19.1	7.10
8	832 q/ha $CaCO_3$	8 ± 2.3	41 ± 12.1	7.31
9	0.5 q/ha KCl	37 ± 7.0	119 ± 1.0	5.60
10	5.01 q/ha KCl	32 ± 11.1	116 ± 10.0	5.50
11	13 q/ha $CaCO_3$ + 1.05 q/ha KCl	31 ± 7.1	125 ± 1.6	5.81
12	13 q/ha $CaCO_3$ + 10.57 q/ha KCl	26 ± 5.5	110 ± 11.3	5.51

In the field experiments the available Mn content of the soil and the total Mn content of plants, as well as relationships between these factors and the yield were studied.

According to our investigation no correlation between the exchangeable Mn content of the soil and the Mn content of red clovers was found ($r = +0.319$; $n = 12$).

There was, however, a positive – though not close – correlation between the active Mn content of the soil and Mn contents of red clovers.

$$X = \text{active Mn}$$

$$Y = \text{Mn of plants}$$

$$r = +0.617 \qquad n = 12 \qquad p = 5\ \%$$

$$Y' = 52 + 0.38 \cdot X$$

This result too proves that the Mn condition of soils is well characterized by the active Mn content.

We studied also the relationship between the Mn content in red clover and the amount of yield and found a close correlation between them; this correlation is not, however, linear. The correlation can be expressed by a cubic equation.

$$X = \text{Mn of plant}$$

$$Y = \text{yield}$$

$$R = 0.667 \qquad n = 8 \qquad p = 10\ \%$$

$$Y' = -204.1 + 7.962\ X - 0.01037\ X^2 - 0.0026\ X^3$$

In the present case only eight treatments were used in the correlation calculations, as treatments 9, 10, 11 and 12 contained also the effects of other factors (e.g. the effect of KCl treatment, see Table 2).

Since the correlation is expressed by a cubic equation we can establish that the Mn content of plants is optimum when the lime dosis is optimum, and the amount of yield – under the given conditions – is the highest, that is, also optimum. Thus, we can draw the conclusion that lime doses should be determined in such a way as to decrease the Mn content of plants only to a level where it does not reduce the yield. In our opinion, correlation of the second degree expresses further that both high and low Mn contents are unfavourable for red clovers.

Consequently, in the pseudogley brown forest soils examined optimum yields were not obtained either without liming or with overliming.

Table 3

Changes in the Mn and Mo contents of red clovers as a reaction to liming
Data relate to air dried matter

Number of sample	Mn ppm			Average I + II + III	Mo γ/kg		Average γ/kg
	I	II	III		I	II	
1	125.0	116.0	114.0	118 ± 3.2	52	55	53.5 ± 2.1
2	93.4	104.0	116.0	104 ± 13.2	64	50	57.0 ± 4.2
3	69.4	80.0	92.0	80 ± 6.1	56	50	53.0 ± 4.2
4	65.4	80.0	78.0	74 ± 4.3	36	70	73.0 ± 4.2
5	92.0	80.0	72.0	81 ± 5.7	72	85	78.5 ± 8.5
6	85.4	66.0	76.0	76 ± 5.6	68	85	76.5 ± 12.0
7	81.4	66.0	72.0	73 ± 4.3	84	98	91.0 ± 9.9
8	89.4	54.0	78.0	73 ± 10.3	106	113	109,5 ± 4.9
9	132.0	140.0	105.0	126 ± 10.6	16	20	18.0 ± 2.8
10	215.6	178.0	112.0	168 ± 16.8	12	25	19.5 ± 10.6
11	77.4	84.0	83.0	81 ± 3.1	32	20	26.0 ± 8.5
12	93.4	80.0	70.0	81 ± 6.6	16	20	18.0 ± 2.8

Note: I. time of sample taking: 4th October 1966, clover undersown
II. time of sample taking: 9th June 1967, first cutting
III. time of sample taking: 1st August 1967, second cutting

Table 4

Changes in red clover yield (fresh crop) under the influence of liming
(average of two cuttings)

Treatment	kg/100 m^2 q/ha	q/cad. yoke	%
1	162.42	94.3	100.0
2	211.31	121.6	130.1
3	249.41	143.5	153.5
4	239.64	137.9	147.5
5	196.86	113.3	131.2
6	189.42	109.0	116.6
7	189.62	109.1	116.7
8	184.64	106.2	113.6
9	179.42	103.2	110.4
10	153.54	88.3	94.6
11	239.08	137.5	147.2
12	151.64	144.8	154.9
s.d. 5%	46.0	26.47	28.31

In case we calculate the correlation with all 12 treatments taken into consideration, a negative linear correlation between the Mn content of red clover and the amount of yield is obtained.

$$X = \text{Mn of plant}$$

$$Y = \text{yield}$$

$$r = -0.665 \qquad n = 12 \qquad p = 2\,\%$$

$$Y' = 271.7 - 0.725 \cdot X$$

This can be explained — in our opinion — by an increase in the active Mn content of soil under the influence of KCl treatments and — in close connection with it — an increase in the Mn content of red clover too. However, this increase of Mn-contents is not favourable for the plants any longer, that is why the yield decreases.

Further we studied the correlation between the various Mn forms of plants and the red clover yield.

A close correlation was found between the exchangeable Mn content of the soil and the yield.

$$X = \text{exchangeable Mn}$$

$$y = \text{yield}$$

$$R = 0.961 \qquad n = 8 \qquad p = 0.1\,\%$$

$$Y' = -199.6 + 9.489\,X - 0.163\,X^2 - 0.00348\,X^3$$

A good correlation was also found between the active Mn content of the soil and the red clover yield

$$X = \text{active Mn content of the soil}$$

$$Y = \text{yield}$$

$$R = 0.876 \qquad n = 8 \qquad P = 1\,\%$$

$$Y' = 173 - 11.14\,X + 0.2058\,X^2 - 0.00089\,X^3$$

Above correlations prove that determination of the Mn supply of soils is suitable for determining both the active and the exchangeable Mn content of the soil. Exchangeable Mn content too characterizes well the Mn conditions of the soil and, therefore, can be well used also in relation to plant nutrition (fertilization), if we want to study the effect of liming. If — in addition to liming — effects of other factors are also involved then active Mn content characterizes the Mn conditions of soils, in a better way, as we have previously seen it.

The cubic equation indicates — in our opinion — that an optimum Mn supply of plants and optimum yields are rendered possible by an optimum active Mn content in the soil.

In the case of red clover the optimum active Mn content of the soil is 110 ppm, while that of plants 80 ppm. According to our investigations a Mn content higher than 220 ppm is unfavourable for red clovers, but one below 70 ppm is also unfavourable. In the soil active Mn above 130 ppm is of toxic effect, but below 100 ppm it is not sufficient.

Investigation also showed that the highest yield was obtained with a quarter of the lime dosis calculated on the basis of hydrolytic acidity (104 q/ha $CaCO_3$). Optimum active Mn content of the soil as well as optimum Mn content of plants were also found with this dose of lime applied.

Thus, our investigations suggest that high doses should not be used while liming the soils, since large quantities of lime getting into the soil impair the Mn supply of red clovers which results in a reduced yield.

The examination prove further, that the active Mn content of the soil is highly responsive to liming, thus the effect of liming can also be seen from the extent to which the active Mn content of the soil has decreased. According to our investigations liming should be applied only in doses which do not decrease the active Mn content of the soil below 100 ppm and do not increase its pH-value above 6.0. This value is sufficiently close to Hargitai's (1966) "biochemical threshold value", that is 5.5 pH, which proves that our conclusions are right, as similar results have been obtained by the different methods. Namely, if the optimum nitrogen supply of soils is a value similar to the pH-value required for the optimum active Mn content of soils, then this fact should be taken into consideration while liming the soils.

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EXAMINATION ON THE EFFECT OF FERTILIZERS ON THE BREWING QUALITY OF BARLEY ON THE BASIS OF THE "BARLEY COMPLEX BREWING INDEX"

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Nitrogen topdressing considerably impaired the brewing quality of winter and summer barleys as compared to the untreated control. K doses markedly improved the brewing quality. As contrasted with N application of NPK doses improved the brewing quality though could not totally compensate the reducing effect of N doses. Barley complex brewing indices show considerable qualitative differences even with minor changes in the qualitative components of the individual fertilizer applications. Thus the indices are apt to reveal minor changes in quality caused by the various fertilizer treatments.

Introduction

A constant problem of our barley growing has been to produce good quality barley. Breeders promote the solution of this task through the breeding of barley varieties that are more productive and of better quality than those grown up to now. Fertilizers applied in higher doses than so far have a similarly important role. It is a well-known fact that the grain yields of cereals can be most easily increased by high doses of N fertilizers. However, the relatively weak straw of winter and summer barleys is an obstacle to the high rate use—and especially to one-sided N fertilization. Therefore harmonic NPK fertilization of barley is a well proved method today. Brewing quality of barley as well as its components are greatly influenced by various simple and combined fertilizer rates. As a result of the complex character of brewing quality the evaluation of qualitative changes caused by fertilization raises a methodological problem. Present paper discusses the effect of various fertilizer rates on the grain yield and grain quality of winter and summer barleys. We wish to find an answer to the question too, whether the "barley complex brewing index" (BCBI) is suitable for characterizing the changes of quality.

There is a poor recent literature in Hungary which deals with the effects of fertilizers on barley quality. KUTHY—FERENC (1960) pointed out, that the protein content of winter barleys can be considerably increased by N fertilizer spray. In the foreign literature many publications deal with the effect of fertilizers on quality. ULONSKA (1961, 1964a, 1964b), BROUWER—MARTIN—TABATABAI (1961), HEYLAND (1961), SOWINSKI (1963), ROEBERS (1964) and others reviewed in their summarizing studies the major part of the respective literature of the fifties. Similar to the earlier period, the publications of the sixties have dealt predominantly with the effects of N fertilizers.

It is a generally accepted opinion that basic nitrogen (N) fertilizers and early N topdressing increase the grain yield in most cases. Results and opinions concerning the qualitative response are, however, highly contradictory. In the experiments of SELKE (1959), BEATH—TOOGOOD (1960), REISENAUER—DICKSON (1961), BROUWER—MARTIN—TABATABAI (1961), KANDERA (1965) and others N fertilization — especially top dressing with high doses increased the protein content. According to MEINX—WALTL (1964), however, the effect depends on the variety, while in ZOSCHKE's opinion (1967) fertilizer rates are effective only to a certain limit. WIDDOWSON—PENNY—WILLIAMS (1961) suggest that N fertilizers decrease the sifting percentage, according to MEINX—WALTL (1964) they decrease the Kolbach's value, while in REISENAUER—DICKSON's opinion (1961) they decrease the thousand-grain-weight but increase the enzyme- and extract content. WILTEN—COENRADIE (1960) call attention to the fact that in dry weather N fertilizers applied late in the season often have no effects. HÄNNINEN—KAILA (1961) found that calcium ammonium nitrate reduced the protein content. In the experiments of DUBETZ—WELLS (1968) nitrogen content of the grain increased, decreased or remained unchanged as a function of the variety.

In the experiments of MOSOLOV—ALEKSANDROVSKAYA (1960) phosphorus (P) doses had no effect on quality; in KANDERA's (1960) experiments they increased while in STROBL's (1960) and KARMANENKO's (1966) experiments decreased the protein content. STROBL (1960) studied the increase of full value malting barley ratio, while STERN—WRIGHT (1962) that of the thousand-grain-weight and decrease of enzym-activity in case of Ph fertilization.

There are relatively few experimental data available concerning the effect of potassium (P) fertilization on brewing quality. HONG (1960) mentions that in his experiments potassium rates increased the starch content of grains and the thousand-grain-weight. KANDERA (1965) and HARALANOV (1968) report on an indirect quality-improving effect of potassium fertilization.

On these bases BITTERAUF (1960), FRANKE (1961), BÖHMER (1962), BRANDENBURGER (1962), GÖPP *et al.* (1963), BAJCI—HAMPL—IVANIC (1966), HARALANOV (1968) and others suggest that in most cases good brewing quality can be attained only by a balanced, harmonious nitrogen-phosphorus-potassium fertilization. At the same time, due to differences in site, variety and climatic conditions, the optimum nutrient ratios of 1 : 2 : 3, 1 : 4 : 5, 1 : 1,2 : 2, and 1 : 1,2 : 1,5 respectively suggested by the same authors can only be considered of informative nature. It can be seen from the data that recently the closer ratios are considered as optimum.

Material and Method

Our fertilization experiments were carried out in 1967—68 at the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvásár, by using winter and summer barleys. The data were evaluated by variance analysis. The experiments were arranged in 5×2 Latin square design, and the plot size was 28.7 m^2.

In five winter barleys the effect of increased rates of NPh, PhP and NPhP basic fertilization as well as of the same treatments completed by high rate nitrogen top dressing in spring on the amount and quality of grains was compared with the effect of basic fertilization (Table 1).

In summer barleys the effect of N, Ph, P and NPhP applied as basic fertilizers on the amount and quality of grains was compared to the untreated control (Table 3). In both experiments the effect of fertilization was characterized by the indices of grain yield, lodging and plant height as well as by the BCBI and its components. The method of determining the BCBI was discussed in two earlier papers (POLLHAMER 1968, 1969).

Results

In the winter barley experiment only the basic fertilization increased by 26 kg/ha potassium and 52 kg/ha phosphorus showed significant and non-significant yield surpluses, respectively, as compared to the untreated control. The high rate basic winter fertilization and N top dressing in spring caused a non-significant reduction in yield. The poor effect of fertilization on lodging can be traced back to weather either drier than the average or tending to turn dry at the end of the season. Treatments, especially nitrogen top dressing partly increased the plant height significantly, while lodging was significantly increased by all treatments (Table 1).

Basic fertilizer combination — except for the high rates of nitrogen fertilization in the autumn — did not generally influence the qualitative factors significantly. Nitrogen fertilizers — especially high rates of N top dressing — significantly increased the protein content and seed-coat ratio, decreased the thousand-grain-weight, non-significantly increased the swelling percentage and the hl weight, on the other hand decreased the germinating ability. The BCBI as the resultants of the qualitative components proved that basic fertilizer rates applied in the autumn did not influence the brewing quality of winter barleys examined, while high rates of N fertilization in the autumn and N top dressing in spring considerably impaired it (Fig. 1, Table 2).

Ph and P basic fertilizers increased, in comparison with the basic fertilization decreased in a sense, the unfavourable effects of N doses on quality but under the given conditions could not totally compensate them. Data call attention to the fact that under similar conditions balanced fertilization may improve while one-sided N fertilization impairs the quality from the point of view of brewing industry.

The treatments applied have similar effects on the feeding quality of winter barley too with the important exception that the increasing effect of N fertilizers on protein content is a favourable feature when employed this way.

Table 1

Treatments and results of fertilization experiments with winter barley
Martonvásár, 1968

Treatments	Active agents of autumn basic fertilization, kg/ha			Active agent of spring top dressing, kg/ha	Grain yield q/ha	Lodging %	Plant height cm
	N	Ph	P	N			
M^0	—	—	—	—	58.3	18.0	97.2
M_1	26	52	16	—	58.5	28.0	98.2
M_2	52	102	16	—	61.1	28.0	98.0
M_3	102	52	16	—	52.6	38.0	97.0
M_4	26	52	52	—	64.2	24.0	101.8
M_5	68	102	26	—	60.4	32.0	99.4
M_6	26	52	16	68	57.2	40.0	99.8
M^7	52	102	16	68	55.7	44.0	101.4
M^8	102	52	16	68	57.2	46.0	100.4
M^6	26	52	52	68	58.1	48.0	97.6
Mean	—	—	—	—	58.3	34.6	99.0
Sign. diff. 5%	—	—	—	—	3.5	9.8	2.7

Table 2

Mean and significant difference values of qualitative components in winter barley at 5 per cent level
Martonvásár, 1968

Qualitative components	Mean	Significant difference 5 per cent
a) thousand-grain-weight	37.1	1.6
b) sifting percentage	38.3	9.0
c) protein content (per cent)	12.3	1.1
d) germinating ability (per cent) ...	90.5	4.0
e) swelling index (per cent)	66.4	6.3
f) seed-coat percentage	14.2	0.1
g) hl weight kg	66.3	2.0
h) extract content (per cent)	78.0	—
i) complex brewing index	38.0	—

The biological value of protein content increased by fertilization has been a question not clarified so far.

In the summer barley fertilization experiment the response of MK 42 was examined with 10 basic fertilizer treatments. As compared to the untreated control only the 68 kg/ha potassium fertilizer gave an almost significant yield surplus. High rate of N fertilization significantly increased the plant height and reduced the grain yield, although in this year no lodging occurred in summer barley. Ph and P fertilization decreased the unfavourable effect of the increased nitrogen rates, though could not perfectly compensate it. The highest reduction in yield was resulted by the increased N doses (Table 3).

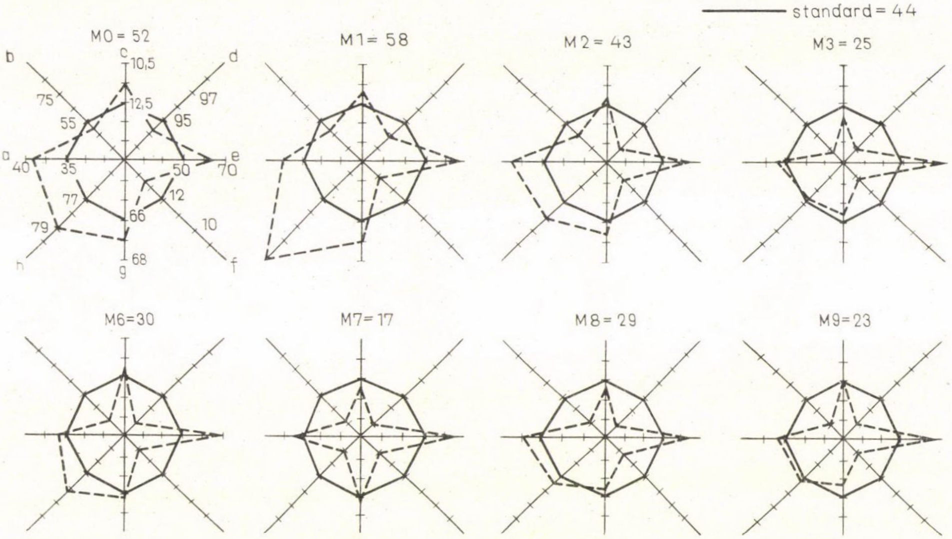

Fig. 1. Changes in the complex brewing indices of winter barleys as a response to fertilization. Martonvásár, 1968

Brewing quality components of the MK 42 summer barley were changed by the various fertilizer rates in different ways. The 25 kg/ha potassium rate significantly increased the hl-weight, the sifting percentage and non-significantly the thousand-grain-weight. Nitrogen applied at the rate of 175 kg/ha either in itself or in various combinations decreased significantly the same qualitative components and considerably increased the protein content. None of the treatments changed significantly the germinating ability, the swelling percentage and the seed-coat ratio (Fig. 2, Table 4). BCBI as contrasted with the qualitative components, unanimously shows the effect of fertilizers on the brewing quality of barleys. On the basis of the BCBI it can be established that under the given conditions large rates of N basic fertilizers — both in themselves and in combinations — may influence unfavourably the yield and qual-

Table 3

Treatments and results of fertilization experiments with summer barley
Martonvásár, 1968

Treatments	Active agents of autumn basic fertilization, kg/ha			Grain yield q/ha	Lodging %	Plant height cm
	N	Ph	P			
M_0	—	—	—	45.7	—	74.0
M_1	—	68	—	46.7	—	76.2
M_2	—	—	68	48.3	—	77.4
M_3	68	—	—	44.0	—	81.0
M_4	68	26	26	46.2	—	78.6
M_5	173	—	—	42.6	—	82.9
M_6	173	68	—	42.1	—	77.3
M_7	173	—	68	43.7	—	78.7
M_8	173	26	26	43.0	—	80.2
M_9	173	68	68	45.6	—	82.7
Mean	—	—	—	44.8	—	78.4
Sign. diff. 5% ...	—	—	—	2.5	—	2.3

Table 4

Mean value and significant difference of qualitative components in summer barley at 5 per cent
Martonvásár, 1968

Qualitative components	Mean	Significant difference 5 per cent
a) thousand-grain-weight	39.1	2.1
b) sifting percentage	48.7	4.7
c) protein content (per cent)	15.6	0.5
d) germinating ability (per cent) ...	94.3	1.7
e) swelling index (per cent)	72.8	5.5
f) seed-coat percentage	12.0	2.7
g) hl weight kg	71.5	0.2
h) extract content (per cent)	75.6	—
i) complex brewing index	53.3	—

ity of summer barleys without causing lodging. P and — to a lower extent — Ph basic fertilizers may have the opposite effect.

Data of the tables and figures show that in these two fertilization experiments brewing quality of summer barleys was on the average superior to that

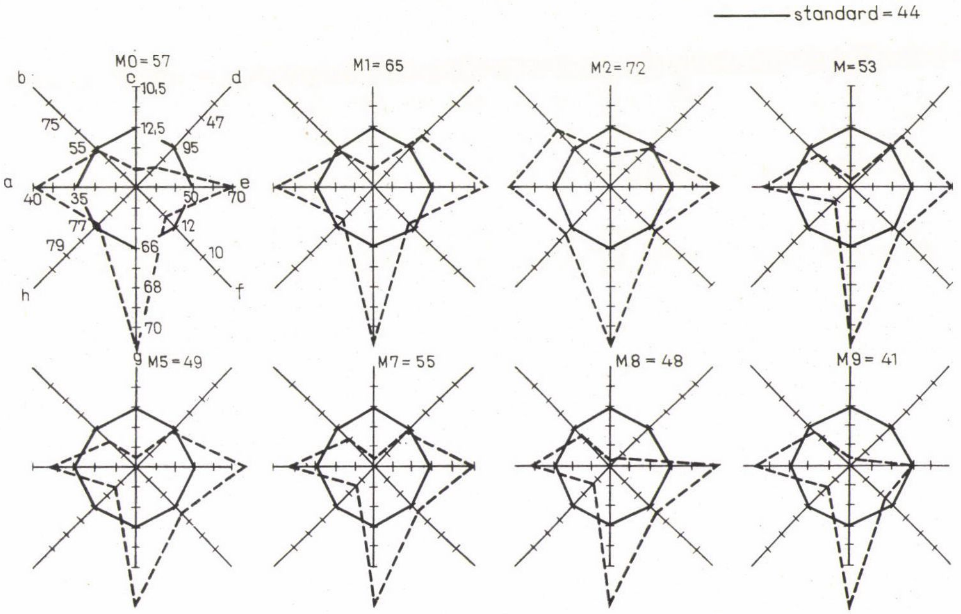

Fig. 2. **Changes in the complex brewing indices of summer barleys as a response to fertilization. Martonvásár, 1968**

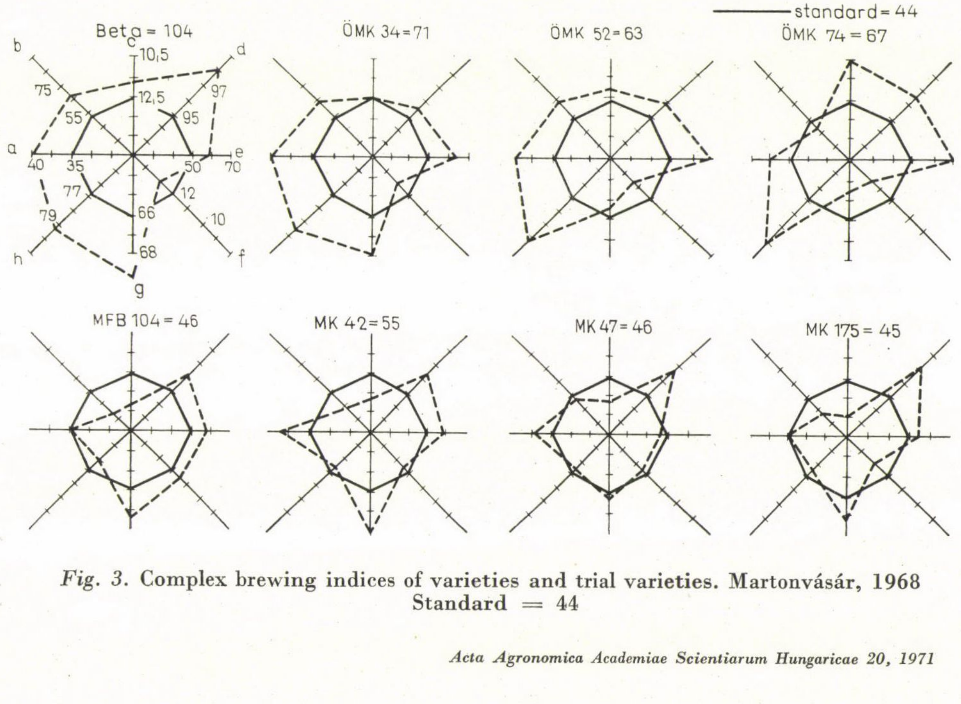

Fig. 3. Complex brewing indices of varieties and trial varieties. Martonvásár, 1968
Standard = 44

of the examined winter barleys. This statement corresponds to our earlier experiences. It is more surprising that this year the brewing quality of winter barley strains is much better than that of summer barley strains grown under similar conditions. In our experimental area 28 : 42 : 56 kg/ha NPhP fertilizers were distributed as basic fertilizers. The complex brewing index of winter barley was 83.3 on the average of 30 strains, while that of the summer barley was only 51.9 on the average of 110 strains. BCBI of the standard variety Beta 40 and our winter barley trial varieties were also much higher than those of our summer barley varieties and trial varieties (Fig. 3). The amount of summer barley useful in brewing industry is below the standard, their seed-coat percentage and especially protein contents are too high. Consequently the extract content too is below the standard and the complex brewing index is around the standard. Among the qualitative components of winter barleys only the too high seed-coat percentage is objectionable, all the other components including the BCBI are high above the standard value of 44.

According to the data winter barley may also be of good brewing quality under exceptional conditions similar to those in 1968, furthermore, fertilization, expecially one-sided and high-rated N application may influence unfavourably primarily the brewing quality of summer barley varieties with later ripening.

Data of Figs 1 and 2 as well as of Tables 2 and 4 prove that the effect of various fertilizer treatments on the quality of barleys can be most easily evaluated on the basis of the BCBI. The complex brewing indices unambiguously show the relatively small, often non-significant and sometimes contradictory changes caused in the qualitative components by the fertilizer treatments. This fact proves the applicability of the complex brewing indices of barley.

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EFFECTS OF GAMMA IRRADIATION IN BARLEY AT DIFFERENT DEVELOPMENTAL STAGES

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The spring barley variety MFB-104 was irradiated at different stages of development (tillering, shooting, meiosis, flowering, zygotogenesis) in the gamma field at Gödöllő. In the year of irradiation (M_1 generation) stalk length, fertility and grain weight decreased while the number of laterals per plant increased. Meiosis was the most reactive phase, while at the stage of zygotogenesis plants of the M_1 generation gave no response to irradiation, and even in the M_2 generation only a slight change could be observed. In the M_2 generation irradiation with a dose of 1944 R at the stage of tillering resulted only in a mutation rate of 2.61 percent. Generation M_3 was evaluated on the basis of a chlorophyll test. With increased doses the frequency of mutations changed. A comparison of phases revealed that the highest mutation frequency was induced by irradiation in the phases of meiosis and zygotogenesis. Treatment at the time of tillering caused but little visible chlorophyll mutation when, however, mutation frequency was converted to mutation rate, the latter value was close to the mutation rates in the other phases. The mutation rate of 7.17 percent obtained with irradiation in the phase of zygotogenesis is, in fact, a higher value, but the mutations produced in multicellular zygotes could not be distinguished from those induced in unicellular zygotes with the method applied. Irradiation in the different phases of development changes the spectre of chlorophyll mutations too, though no definite regularities could be established.

Introduction

Physiological and genetical sensitivity of plants to irradiation is influenced by numerous factors. In addition to the kind and dose of irradiation and the genetic properties of plants (DNA content, ploidy level, heterozygous state, etc.) the developmental stage of a given plant also plays an important role (YAMASHITA 1964). In plants irradiated a complicated chain reaction takes place from the absorption of the radiation energy to the biological effects observable. This process depends to a great extent on whether the living plant tissue examined is in a quiescent stage or is dividing. So far the majority of mutation experiments have been carried out with dormant seeds. A higher availability of radiation sources has made it possible to irradiate dividing tissues and growing plants as well. In such research work the gamma fields, which make irradiation of plants during the whole growth season possible, play an important role. A so called "critical dose" has been established for most higher plants (SPARROW 1965, YAMASHITA 1964) with values determined, however, for the whole vegetation. As to "critical doses" applicable at the different developmental stages of plants few literary data are available (NYBOM—GUSTAFSSON—GRANHALL—EHRENBERG 1956, KAWAI—INOSHITA 1965, HERMELIN 1967). GAUL (1964) and MERICLE—MERICLE (1966) studied the irradiation sensitivity of meiosis, pollen and multicellular zygotes in barley but did not extend their experiments to the various phases of the whole developmental cycle. Similar experiments were carried out with maize. According to these investigations diploten and metaphasis I proved to be the most sensitive phases of meiotic division (SINGLETON 1962).

In the present paper the physiological and genetical radiation sensitivity of barley at the different developmental stages will be dealt with, and on the basis of data obtained some theoretical questions discussed.

Material and Method

In the experiment grains of the spring barley variety MFB-104 were sown into culture pots containing a mixture of compost and forest soil. 15 grains per pot were sown and after having come out 10 plants left. Five culture pots per treatment were used, so in the year of the treatment (M_1) we had 50 plants at our disposal. Irradiation was applied at the following developmental stages: tillering, shooting, meiosis, flowering and zygotogenesis. When determining these phases and starting mutagene treatment the main ear was taken as basis. The phases of meiosis and flowering were controlled cytologically as well.

The irradiation was carried out in the gamma field of the University of Agricultural Sciences at Gödöllő, where a ^{60}CO radiation source of 100 Curie activity was placed at our disposal. Plants were given irradiation for four days per phase (18 hours a day). Three doses were applied in each phase. This was carried out by placing culture pots containing the plants to be irradiated at a distance of 2, 2.5 and 3 meter respectively, from the radiation source, so 1944 R, 1224 R and 864 R values were obtained as integrated doses. The culture pots were arranged on stairs built around the radiation source according to Fig. 1.

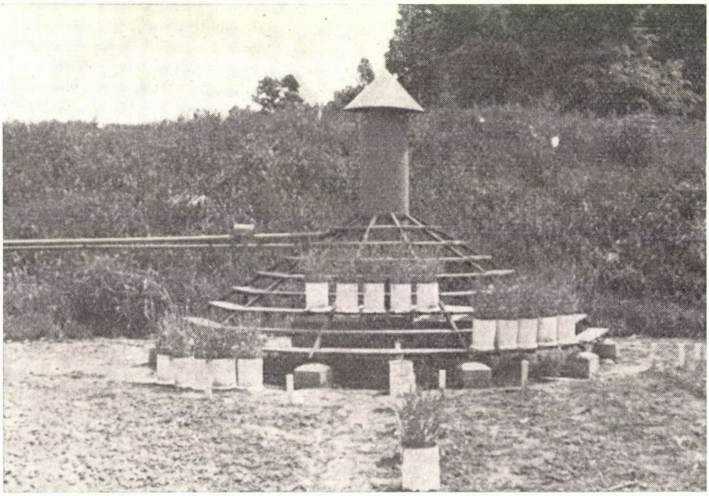

Fig. 1. Source of radiation with the culture pots

The culture pots of the control were given no irradiation. The dates of irradiation are presented in Table 1. For the purpose of evaluating the physiological effects of irradiation some properties were assessed in mature plants at the time of harvesting. The grains collected in the year of the irradiation represented the M_1 generation. From the point of view of mutation analysis this method of marking can be accepted, of course, only for the phase of tillering, for later phases M_0 would be a better marking. With uniformity in view, however, it was desirable to mark each phase with M_1.

Table 1

Phases and dates of irradiation

Developmental phases	Dates of irradiation, 1967
Tillering	April 24—27
Shooting	May 12—15
Meiosis	May 20—23
Flowering	June 3— 6
Zygotogenesis ..	June 9—12

M_1 grains were sown in a small plot experiment with double duplication. The plants that emerged from M_1 grains were uniformly called the M_2 generation. Each plant of the M_2 generation was harvested separately and used in chlorophyll tests under glass-house condition. Ears and grains, respectively, were germinated in a sandy soil at an average temperature of 7.2° C. The seedlings of the chlorophyll test were called M_3 generation. To determine the types of chlorophyll mutation a pattern recommended by Gustafsson (1940) was used.

Results

M_1 generation. The effects of irradiation on the M_1 generation are shown in Fig. 2—5. The changes in the properties examined are plotted by a five axial graph which makes it possible to evaluate phases and radiation doses jointly.

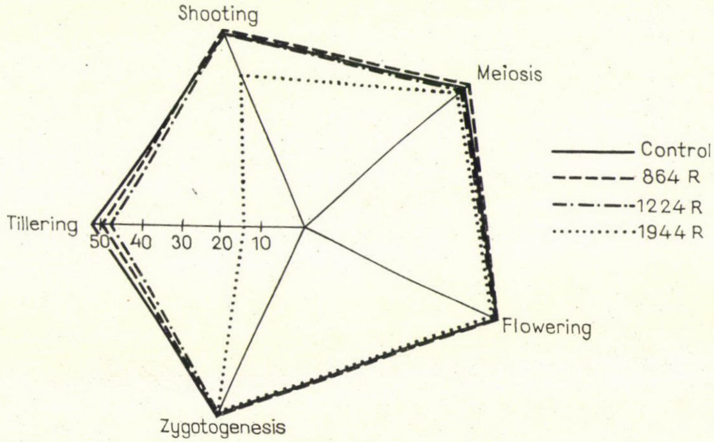

Fig. 2. Effect on plant height of irradiation applied at different developmental stages

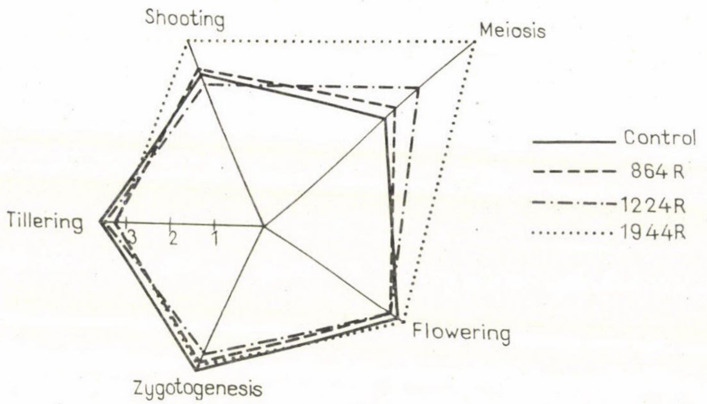

Fig. 3. Effect on ear number per plant of irradiation applied at different developmental stages

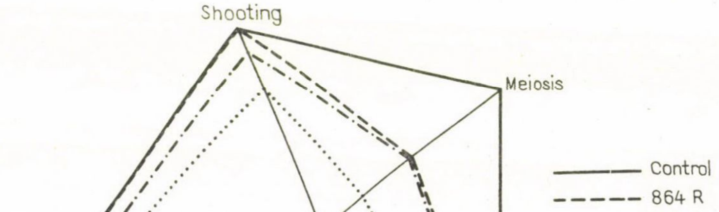

Fig. 4. Effect on fertility of irradiation applied at different developmental stages

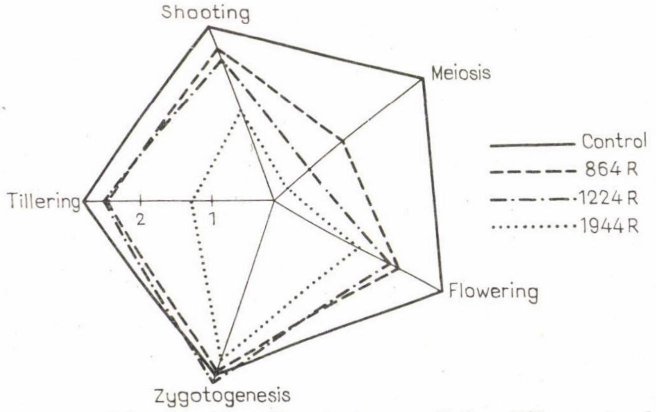

Fig. 5. Effect on grain weight per plant of irradiation applied at different developmental stages

The values of plant height only depend to a low extent on irradiation performed at the different stages (Fig. 2). It is only the dose of 1944 R that reduces the length of the stalk when applied in the phases of tillering, shooting—and to a slight degree at the stage of meiosis. The number of laterals and ears resp. per plant was increased by irradiation applied at the stages of tillering and meiosis. According to Fig. 3 the effect of the 1944 R dose was highly important, though it must be mentioned that these secondary ears usually remained sterile, and were green, even when ears of the other treatments had grown ripe.

Table 2

Changes in the mean values of fertility in the M_2 generation with irradiation applied at different stages of development

Phases	Doses					
	864 R		1224 R		1944 R	
	$\bar{x} \pm s_{\bar{x}}$	%	$\bar{x} \pm s_{\bar{x}}$	%	$\bar{x} \pm s_{\bar{x}}$	%
Tillering	88.10 ± 0.64	96.49	87.80 ± 0.74	96.16	87.10 ± 0.84	95.39
Shooting	85.05 ± 0.73	93.15	90.15 ± 0.63	98.74	85.45 ± 0.94	93.59
Meiosis	86.70 ± 0.70	94.96	89.95 ± 0.56	98.52	84.80 ± 1.21	92.88
Flowering	87.75 ± 1.09	96.11	90.25 ± 0.71	98.84	84.30 ± 1.02	92.33
Zygotogenesis	85.10 ± 0.84	93.20	84.15 ± 1.20	92.16	82.75 ± 1.48	90.63
Control	91.30 ± 0.66	100.00	91.30 ± 0.66	100.00	91.30 ± 0.66	100.00

The most conspicuous changes were observed with the fertility of earlets and grain weight per plant. Irradiation decreased fertility in each phase except zygotogenesis. This change was the greatest when irradiation had been applied at the stage of meiosis, when even such a small dose as 864 R decreased fertility by about 50 percent (Fig. 4).

As to grain weight per plant a similar change was observed with the difference that this property was modified by the dose of 1944 R to an even greater extent than fertility (Fig. 5).

M_2 generation. Physiological changes in the M_2 generation can be expected primarily with irradiation applied at the stage of zygotogenesis. Irradiation decreased fertility compared to the control at every developmental stage, but significant differences (10 per cent) were caused only by doses 1224 R and 1944 R applied at the stage of zygotogenesis (Table 2). Irradiation applied at the stage zygotogenesis increased the number of laterals per plant too.

In plots treated with 1944 R in the phase of tillering several albinos were observed. Their percentage value is 0.52 and mutation rate 2.61 percent. In other phases and with other doses no chlorophyll mutation was found.

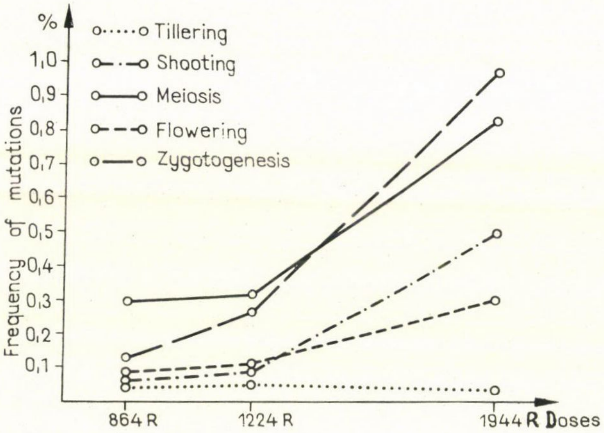

Fig. 6. Frequency of chlorophyll mutations in the M_3 generation

Table 3

Effect of gamma irradiation applied at different phases on the spectre of chlorophyll mutations (%)

Phase	Number of seedlings in M_3	Chlorophyll mutations in M_3	Relative values			
			albina	xantha	viridis	other
			864 R			
Tillering	10,068	4	75	0	25	0
Shooting	12,954	8	38	24	38	0
Meiosis	13,062	38	76	21	3	0
Flowering	12,472	11	36	19	36	0
Zygotogenesis	10,900	14	86	7	0	7
			1224 R			
Tillering	8,924	4	0	0	75	25
Shooting	6,835	6	83	0	0	17
Meiosis	8,791	27	59	4	11	26
Flowering	9,897	11	73	0	0	27
Zygotogenesis	8,794	23	83	0	13	4
			1944 R *			
Tillering	6,425	2	100	0	0	0
Shooting	6,903	36	61	28	11	0
Meiosis	7,048	59	20	21	59	0
Flowering	7,040	21	62	0	38	0
Zygotogenesis	6,967	68	32	32	28	8

* ears laid in wet sand.

M_3 generation. When studying the M_3 generation we used the chlorophyll test. The frequency of chlorophyll mutation was calculated for 100 M_3 seedlings. In the case of 1944 R applied frequency was calculated for 100 M_2 plants as well in order to find a correlation between mutation frequency and mutation rate. Frequency of chlorophyll mutation in generation M_3 is shown by Fig. 6.

According to Fig. 6 mutation showed the lowest frequency with irradiation applied at the stage of tillering. The phase of meiosis proved highly sensitive, however a dose of 1944 R applied at the stage of zygotogenesis resulted in a higher frequency of mutation. As to the frequency of mutation, shooting and flowering are stages intermediary between meiosis and tillering. It can be seen further, that with the exception of tillering the values of the mutation frequency also depend on the dose and increase considerably when 1944 R is applied.

With a view to studying the mutation spectre it was interesting to evaluate the relative frequency of chlorophyll mutation types in the given treatments. The frequency of albina, xantha and viridis was especially interesting, since in the other categories *(alboviridis, viridoalbina, alboxantha, xanthaalba, striata, tigrina* and *maculata)* very few mutations were found. According to Table 3, albina occurs with the highest frequency followed by viridis with all three doses applied. When the phases are examined regularities are more difficult to be found. It seems an important correlation that with irradiation applied at the stages of meiosis and zygotogenesis, the relative values of albina are highly reduced by the increased doses, and in the case of the 1944 R dose show only 20 and 32 percent, respectively.

From both theoretical and practical points of view it is important to study the relationship between the changes of fertility in plants of the M_1 and M_2 generations on one hand, and the frequency of chlorophyll mutations in the M_3 generation on the other. Table 7 shows a close correlation between fertility and chlorophyll mutation in the M_3 generation in our case.

Treatment at the stage of meiosis considerably decreases fertility in M_1, the percentage value of chlorophyll mutations in M_3 seedlings is 0.84 per cent; at the same time irradiation in the phase of zygotogenesis hardly decreases the fertility percentage either in M_1 or in M_2 generations, on the other hand the value of the mutation frequency is 0.98 percent, that is, when the phases are compared, the highest mutation frequency is found in this case.

Since in certain cases — e.g. when living tissues are irradiated — a competition develops between mutated and non-mutated cells and so the diplontic selection results in the elimination of some cells, it is necessary to determine the mutation rate for nuclei in the M_1 (in our case M_2) generation. According to Gaul (1964) the mutation rate can be converted by dividing the percentage frequency of mutants in M_2 seedlings by the segregation percentage of chlorophyll mutations. The segregation percentage of chlorophyll mutations does not generally amount to 25%, according to GAUL (1964) and MERICLE—MERICLE (1966) it is 20% when the nucleus is irradiated. It can also be understood that when the embryo cells, pollen, egg-cells or multicellular zygotes are irradiated,

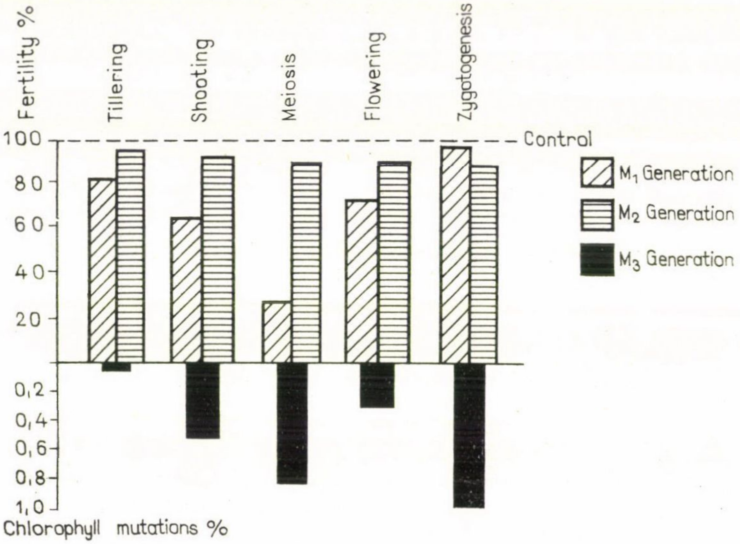

Fig. 7. Relationship between fertility and chlorophyll mutation in the case of the 1944 R dose used

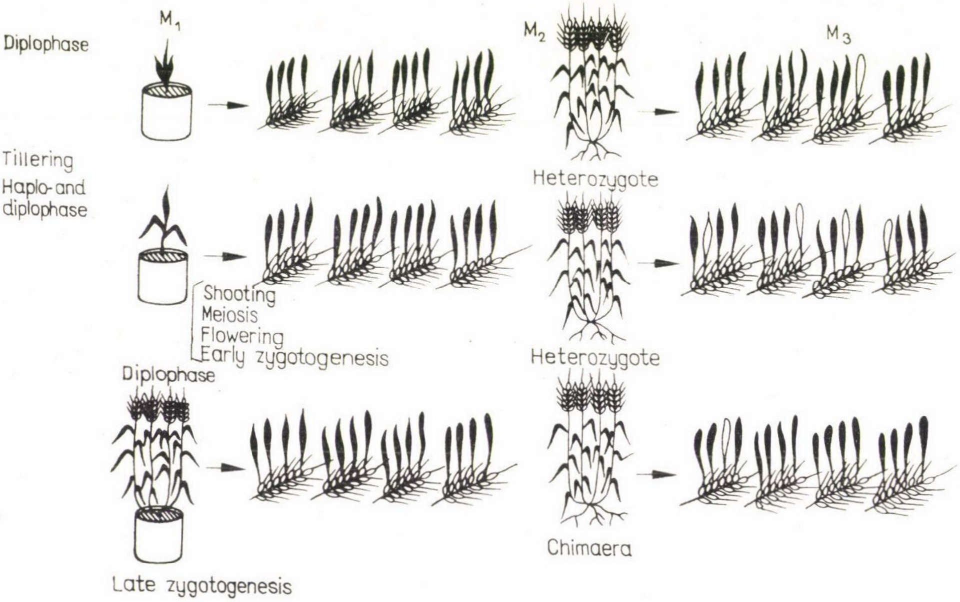

Fig. 8. Segregation of chloropohyll mutations with gamma irradiation applied at different stages of development

the percentage frequency of the mutated M_1 (in our case M_2) plants will be equal to the mutation rate. With this taken in consideration, the values of the mutation rate were calculated in the case of 1944 R applied (Table 4).

Introducing the concept of mutation rate we can see that the mutation rate of tillering exceeds those of shooting and flowering. Compared to the 4.62 value obtained by irradiation at the time of meiosis, this value was 7.17 with irradiation performed at the stage of zygotogenesis. It should be mentioned that the latter value may perhaps be higher, since it contains the values of mutation frequency and mutation rate jointly, as in the present case it is not possible to separate them.

Table 4

Values of mutation rate in the M_3 generation in treatments given a dose of 1944 R

Phase	Number of M_2 plants tested	Number of M_2 plants mutated	Mutation rate in M_3, %
Tillering	129	1	3.89
Shooting	138	5	3.62
Meiosis	141	6	4.62
Flowering	141	3	2.13
Zygotogenesis ..	139	10	7.17
Control	137	0	0.00

Discussion

Barley plants irradiated at different stages of development showed considerable differences in radiosensitivity in the generations examined. Nybom *et al.* (1956) did not find any difference in the frequency of chlorophyll mutations when irradiating barley in different periods of the vegetation cycle on a gamma field. Our own results confirm first of all the data obtained by Hermelin (1967) who found meiosis and early embryogenesis to be the most radiosensitive phases, but demonstrated this conclusion of his only by determining fertility and mutation frequency. When studying the radiosensitivity of rice at the different developmental stages Kawai—Inoshita (1965) similarly found a relatively high number of mutations in generation M_2 in the case of irradiation applied at the time of tillering and panicle formation. This was not confirmed by our data obtained with barley.

Radiosensitivity of the individual phases of development can be well proved with grain weight per plant — in addition to the fertility of the M_1

generation. Experiments performed by ZEZYULINSKIY—GRECHANOVSKAYA (1968) also testify that gamma irradiation carried out at the time of the zygotogenesis reduces the grain weight per plant and the thousand-grain-weight.

In the case of irradiation carried out at the time of tillering, shooting and meiosis the change in the fertility of the plants showed the same correlation as the frequency of chromosome aberrations (translocation, inversion, iso- and pseudo-iso-chromosomes, bridges, fragments) observed in the phase of meiosis following irradiation (SUTKA—PETROVICS 1970). According to GAUL (1964) and MERICLE—MERICLE (1966) if there is no competition between mutated and non-mutated cells in an irradiated living tissue, then the mutation rate can be increased. This can be realized in principle by irradiating the spermatozoon, the gamete, and the zygote consisting of a few cells. Tissue thus mutated will not be chimaeric, that is, in the case of a mutative segregation each ear of the plant will contain mutative progenies. This supposition is shown in Fig. 8. In the phase of tillering, since irradiation was applied in the diplophase, mutation may occur even in the M_2 generation, but then not in every ear of the plant. The case may be similar in the M_3 generation. With irradiation performed at the stage of late zygotogenesis mutation can be found only in the M_3 generation. Due to the chimaeric character of the irradiated grain primordium only few ears of the M_3 plant show mutation. A certain extent of haplontic selection may occur with plants treated at the time of spermatozoon- and gamete formation as well, but the segregation percentage of chlorophyll mutation will certainly be closer to 25% than when dormant seeds are irradiated. This principle was but partly proved by our experiments, because mutation rates obtained by irradiation applied at the time of meiosis, flowering and zygotogenesis did not much exceed those that resulted from irradiation at the time of tillering.

We have already mentioned that in our experiment the 7.17% mutation rate obtained with plants irradiated at the time of zygotogenesis is not a "pure" mutation rate, since some zygotes were in a multicellular state when irradiated, and in these embryos diplontic selection occurred in the same way as in the case of grains irradiated. It is known from the literature (MERICLE—MERICLE 1966, DONINI *et al.* 1968) that the later irradiation is carried out in the course of the embryonal development, the lower the proportion of the mutation sector will be in the seed, consequently, the lower the number of ears per plant showing mutative segregation will be. Partly on this basis, partly on the basis of the high fertility observed in generations M_1 and M_2 in our experiment, we consider it justified to carry out irradiation at the time of early zygotogenesis.

Changes in the spectre of chlorophyll mutation show a tendency similar to those in the literature (GAUL 1964, KAWAI—INOSHITA 1965). The distribution of the chlorophyll mutation types discussed with the results is considered but approximate, as any decision made on the question would require more chlorophyll mutations.

Acknowledgement

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EFFECT OF PRODUCTION FACTORS ON GRAIN YIELD AND YIELD ELEMENTS OF WHEAT VARIETIES IN POLYFACTORIAL EXPERIMENTS

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Factors primarily determining the trends of wheat yields, as well as their interactions, were studied in polyfactorial experiments during three successive years. The experiments were conducted in fractional replications; in the 81 "main plots" arranged in 9 blocks three variants of soil cultivation, sowing depth, stand density and sowing time were studied with each of the three varieties used, while within the 81 main plots in 729 "sub-plots" (arranged in split-plot design) 9 combinations of three different nitrogen fertilization levels and fertilization times were compared. The paper describes the conditions and methods of the experiment series, the techniques of the experiments, and presents simple and bifactorial analyses of basic data on grain yield, ear compactness, ear productivity and thousand-grain-weight as well as the significant results of the experiments. On the average of three years the factors examined influenced the yield in the following order: nitrogen fertilization, variety, time of sowing, soil cultivation, depth of sowing, number of plants and time of nitrogen application.

Introduction

During the past decade a considerable number of monofactorial wheat experiments were carried out at the Institute, that is, a single factor was studied at a time in various combinations. However, yield is usually a function of the interaction between more than one factors. By the modern factorial experiment designs (Fischer 1953), the complex study of more than one factors at the same time, partly a separate discussion of their simple (average) effects, partly a detailed analysis of interactions are made possible.

At the Agricultural Research Institute of the Hungarian Academy of Sciences at Martonvásár factors primarily determining yield trends in wheat as well as their interactions were studied in such factorial experiments during three successive years. In the experiments carried out in 729 plots three varieties were used every year to compare three variants per each of soil cultivation, sowing depth, stand density, sowing time, N-fertilization and fertilization time. Each of the 7 factors was studied in three stages and each stage was repeated 27-times, the N-dosage- and fertilization-time stages as many as 81-times; nevertheless the experiments covered only one third of the possible combinations.

The conditions, methods and most important results of experiments carried out in 1960–61, 1961–62 and 1962–63 (Koltay 1962), as well as the

Table 1

Precipitation data obtained on the area of the experiment

(1) Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	(2) Total
a) Average of 1901—1940, mm	31	31	39	46	66	62	50	52	52	53	46	43	571
1960													
b) precipitation mm	29	39	29	45	30	64	112	34	62	99	127	39	709
c) deviation mm	−2	8	−10	−1	−36	2	62	−18	10	46	81	−4	138
d) deviation %	−6	26	−26	−2	−54	2	124	−35	20	86	175	−10	24
1961													
b) precipitation mm	20	46	0	45	68	22	29	6	2	19	100	33	390
r) deviation mm	−11	15	−39	−1	2	−40	−21	−46	−50	−34	54	−10	−181
d) deviation %	−34	47	−100	−2	4	−63	−41	−89	−97	−64	120	−22	−31
1962													
b) precipitation mm	34	16	34	44	32	16	44	1	30	6	187	31	475
c) deviation mm	3	−15	−5	−2	−34	−46	−6	−51	−22	−47	141	−12	−96
d) deviation %	8	−47	−13	−5	−52	−74	−12	−97	−42	−89	305	−28	−17
1963													
b) precipitation mm	70	75	29	43	25	72	58	68	103	17	17	38	615
c) deviation mm	39	44	−10	−3	−41	10	8	18	51	−36	−29	−5	44
d) deviation %	13	14	−26	−6	−62	16	16	31	98	−68	−63	−12	8

Table 2

Treatments in the "fractionally repeated" factorial experiment, and the arrangement of treatment combinations

Treatments			
a = soil cultivation (T)	shallow	normal	deep ploughing
b = variety (F)	Fertődi 293	Besostaya	San Pastore
c = depth of sowing (V)	4 cm	6 cm	8 cm
d = number of germs (C)		million/ha	
Fertődi 293	4.52	5.04	5.56
Besostaya	5.04	5.56	6.08
San Pastore	6.43	6.95	7.47
e = time of sowing (I)			
1960–61	20 October	27 October	4 November
1961–62	2 November	4 November	10 November
1962–63	11 October	23 October	5 November

Arrangement of treatment combinations								
abcde	*abcde*	*abcde*	*abcde*	*abcde*	*abcde*	*abcde*	*abcde*	*abcde*
12102	11022	00120	20001	10212	02010	01200	21111	22221
12222	02100	21201	10002	20121	11112	22011	01020	00210
21120	20010	00102	11001	10221	12111	22200	01212	02022
02121	22002	00201	21222	11100	20112	01011	12210	10020
10122	21021	02220	12012	01110	00000	11202	22101	20211
12120	11010	02001	10200	00111	22212	21102	01221	20022
12201	21210	20100	01002	02112	22020	10011	00222	11121
11220	20202	01101	22122	12000	00021	10110	02211	21012
10101	21000	01122	00012	20220	22110	12021	02202	11211

methodological principles and data processing (Koltay—O'sváth 1963) have already been published. O'sváth—Papp (1963) have further published the results of the shading experiments conducted in the first year.

The present paper discusses the most characteristic effects and interactions found during the analysis of basic data on grain yield, ear compactness, ear productivity and thousand-grain-weight of the three years' experiment series.

Material and Method

The experiments were carried out in three adjacent sections of the Institute's U_1 parcel, in a medium fertile chernozem soil of a cleared woodland, in 1960—61 and 1961—62 after a first crop of Sudangrass grown for green fodder and cut twice, while in 1962—63 after summer barley.

According to the meteorological observations performed on the area of the experiment, the crop year of 1960—61 was considered very good, that of 1961—62 medium while 1962—63 highly unfavourable. In the crop year of 1962—63 the extremely hard winter that lasted from November 23rd up to the end of March caused a considerable thinning even of the varieties Fertődi and Besostaya, while the variety San Pastore suffered a 50—60 percent frost damage. Precipitation data obtained on the area of the experiments are presented in Table 1 as monthly and yearly totals and in comparison with 40 years' mean values calculated for Martonvásár.

The basis of the 3^7 factorial experiment is a 3^5 factorial experiment scheme with "fractional replications", the plots of which are further distributed into $3^2 = 9$ sub-plots (arranged in a "split-plot" design). The treatment combinations of the main plots of the experiment, after being arranged in 9 random blocks are shown in Table 2.

The factors *a), b), c), d)* and *e)* were combined in 81 main plots arranged in 9 blocks according to the design — randomized basic scheme No. A, 19. by COCHRAN—COX (1957) — shown in Table 2 in such a way that each factor was repeated 27-times, always in a different combination (e.g.: treatments in the main plot 12102: normal ploughing, variety San Pastore, 6 cm depth of sowing, a seed amount of 6.43 million grains per ha sown in the first year on 4th November).

Each "main plot" — of the size of 259 m² without paths, borders and buffers — included 9 28.788 m² sub-plots arranged in random split-plot design, so the experimental area consisted of 81×9 = 729 sub-plots apart from the buffers separating the main plots. In the sub-plots 9 combinations of three different nitrogen doses and three different times of fertilization were set up — similarly at random —, so the fertilization treatments were repeated 27-times with each variety, i.e. altogether 81-times in the experiment.

Fertilization treatments of sub-plots:

a) Time of application (M)
  0 (immediately before sowing in autumn)
  1 (in winter, in three equal parts. In 1962—63 two equal parts in spring)
  3 (at the end of winter)
b) Dose (N)
  0 (untreated control)
  1 (87 kg/ha N)
  2 (174 kg/ha N)
  Combinations:
  ab

1. 00 (in autumn ∅)
2. 01 (in autumn 87 kg/ha N)
3. 02 (in autumn 174 kg/ha N)
4. 10 (in winter ∅)
5. 11 (in winter, in 1962—63 in spring 87 kg/ha N)
6. 12 (in winter, in 1962—63 in spring 174 kg/ha N)
7. 20 (at the end of winter ∅)
8. 21 (at the end of winter 87 kg/ha N)
9. 22 (at the end of winter 174 kg/ha N)

Autumn N-fertilization was applied prior to the first sowing, winter top-dressing in 1960—61 and 1961—62 in three equal parts (December 16th, January 13th, February 13th; and December 13th, January 15th, February 21st, respectively), while top-dressing at the end of the winter was applied on March 29th in 1962 and April 2nd in 1963.

In the crop year of 1962—63 the actual realization of winter top-dressing under experimental conditions was impossible, because from November 23rd to March 11th the area was covered with snow, and when it suddenly melted the soil was too soft; so we had to be content with the solution of applying top-dressing on two occasions: on April 5th and May 24th. Thus in that year nitrogen applications subjected to a comparison took place in autumn, and at the end of the winter in a single dose, and in spring in two parts, respectively.

Varieties used in the experiments were harvested every year with a Massey—Ferguson combine in the following order of succession: San Pastore, Besostaya, Fertődi (June 30th, July 4th and July 5th, 1961; July 20th, July 24th and July 25th, 1962; July 9th, July 11th and July 16th, 1963).

Grain yields of the 729 sub-plots were collected in separate sacks, stored in a granary, then weighed in an air-dry condition. Prior to harvesting, samples required for the analysis of ears were taken from each sub-plot.

The course of data processing of a single experiment, preparation of 2-dimension- and variance tables etc. have been discussed in full detail by KOLTAY—O'SVÁTH (1963), in some detail by WELLISCH (1961) and BAJAI—O'SVÁTH—SZABÓ (1962).

The experiments were of identical structure in all the three years, so the variance table summarizing the results of the three years' experiment series was not difficult to prepare. When summarizing the years a new factor — "É" (years) — was involved representing the differences caused by the individual years (and places changing from year to year, respectively) in the data of the same experiments. As a result, in the summarized variance analysis of the experiment series interactions of the various effects and interactions with this "É" -factor are also included.

Herewith we express our thanks to Peter Wellisch and János O'sváth scientific research workers for placing the formulas used in calculating the standard error at our disposal.

Results

The 21 two-dimension grain yield tables constructed from 2187 basic data of the three years' experiment series (basic data = kg grain yield of 1 sub-plot) are presented in Table 3. In the summarized two-dimension tables each value of the inner fields represents the kg grain yield of 243 plots, the marginal value that of 729 plots, while the grand total shows the kg grain yield of 2187 plots.

Analysis (made of simple- and bifactorial interactions) of grain yield data is included in the variance table (Table 4).

The table of results of average effects was made of the basic data of the two-dimensional tables by an adequate recalculation. Grain yield was expressed in kg/ha, ear density in ear number per m^2, grain/ear value was reduced to the number of grains per ear, and the sum of thousand-grain weight basic data to the weight of 1000 grains (Table 5).

Soil cultivation treatments caused no considerable differences in the grain yields of either the variety Fertődi or the foreign varieties. On the average of the three years soil preparation with a disc-harrow without ploughing was eventually more efficient than a deeper cultivation, in spite of the fact that seed-beds had to be prepared in the first and second year of the experiment after Sudan grass as first crop, and in the third year after a summer barley crop — under relatively unfavourable conditions.

Interaction between soil cultivation and nitrogen fertilization was not unambiguous. Grain yield differences found between the soil cultivation treatments without fertilization decreased in the first and second, while increased in the third year as a reaction to nitrogen application.

On the average of three years — due to the order of varieties changing from year to year — differences in grain yield between the varieties are not

Table 3

Three years' summarized 2-dimension tables of grain yield data

		F		
	2566.9	2424.1	2207.9	7198.9
T	2411.3	2368.5	2223.6	7003.4
	2383.3	2410.8	2068.0	6862.1
	7361.5	7203.4	6499.5	21064.4

		V		
	2342.9	2451.6	2404.4	7198.9
T	2314.8	2393.0	2295.6	7003.4
	2227.6	2283.6	2350.9	6862.1
	6885.3	7128.2	7050.9	21064.4

		C		
	2469.3	2358.4	2371.2	7198.9
T	2376.2	2270.6	2356.6	7003.4
	2307.6	2266.0	2288.5	6862.1
	7153.1	6895.0	7016.3	21064.4

		I		
	2367.9	2561.4	2269.6	7198.9
T	2446.2	2368.5	2188.7	7003.4
	2442.2	2171.6	2248,3	6862.1
	7256.3	7101.5	6706.6	21064.4

		N		
	1902.3	2587.2	2709.4	7198.9
T	1901.5	2508.9	2593.0	7003.4
	1853.9	2450.9	2557.3	6862.1
	5657.7	7547.0	7859.7	21064.4

		M		
	2377.9	2394.1	2426.9	7198.9
T	2327.5	2309.2	2366.7	7003.4
	2278.4	2289.2	2294.5	6862.1
	6983.8	6992.5	7088.1	21064.4

		V		
	2416.4	2508.2	2436.9	7361.5
F	2346.8	2437.9	2418.7	7203.4
	2122.1	2182.1	2195.3	6499.5
	6885.3	7128.2	7050.9	21064.4

		C		
	2469.5	2456.2	2435.8	7361.5
F	2433.2	2348.1	2422.1	7203.4
	2250.4	2090.7	2158.4	6499.5
	7153.1	6895.0	7016.3	21064.4

		I		
	2496.8	2497.6	2367.1	7361.5
F	2496.2	2425.8	2281.4	7203.4
	2263.3	2178.1	2058.1	6499.5
	7256.3	7101.5	6706.6	21064.4

		N		
	2044.7	2602.0	2714.8	7361.5
F	1866.7	2602.7	2734.0	7203.4
	1746.3	2342.3	2410.9	6499.5
	5657.7	7547.0	7859.7	21064.4

		M		
	2453.8	2430.8	2476.9	7361.5
F	2375.6	2405.6	2422.2	7203.4
	2154.4	2156.1	2189.0	6499.5
	6983.8	6992.5	7088.1	21064.4

		C		
	2362.3	2344.3	2178.7	6885.3
V	2403.4	2292.9	2431.9	7128.2
	2387.4	2257.8	2405.7	7050.9
	7153.1	6895.0	7016.3	21064.4

		I		
	2368.7	2348.5	2168.1	6885.3
V	2473.3	2338.3	2316.6	7128.2
	2414.3	2414.7	2221.9	7050.9
	7256.3	7101.5	6706.6	21064.4

		N		
	1842.3	2475.6	2567.4	6885.3
V	1914.0	2564.2	2650.0	7128.2
	1901.4	2507.2	2642.3	7050.9
	5657.7	7547.0	7859.7	21064.4

	M			
	2267.9	2288.7	2328.7	6885.3
V	2371.2	2360.8	2396.2	7128.2
	2344.7	2343.0	2363.2	7050.9
	6983.8	6992.5	7088.1	21064.4

	N			
	1936.8	2551.9	2664.4	7153.1
C	1822.7	2481.3	2591.0	6895.0
	1898.2	2513.8	2604.3	7016.3
	5657.7	7547.0	7859.7	21064.4

	N			
	1980.0	2587.8	2688.5	7256.3
I	1918.3	2538.7	2644.5	7101.5
	1759.4	2420.5	2526.7	6706.6
	5657.7	7547.0	7859.7	21064.4

	N			
	1899.1	2500.4	2584.3	6983.8
M	1865.0	2518.8	2608.7	6992.5
	1893.6	2527.8	2666.7	7088.1
	5657.7	7547.0	7859.7	21064.4

	I			
	2413.8	2439.5	2299.8	7153.1
C	2393.3	2305.5	2196.2	6895.0
	2449.2	2356.5	2210.6	7016.3
	7256.3	7101.5	6706.6	21064.4

	M			
	2374.8	2375.6	2402.7	7153.1
C	2273.5	2294.1	2327.4	6895.0
	2335.5	2322.8	2358.0	7016.3
	6983.8	6992.5	7088.1	21064.4

	M			
	2395.1	2415.2	2446.0	7256.3
I	2361.6	2359.9	2380.0	7101.5
	2227.1	2217.4	2262.1	6706.6
	6983.8	6992.5	7088.1	21064.4

significant. On the basis of the grain yields of the varieties important interactions can also be pointed out. Without nitrogen fertilization grain yields in the variety Fertődi consistently exceeded those of the two other varieties indicating that under extensive conditions lower requirements are advantageous. Nitrogen application reduced the grain yield differences between the varieties, and even reversed the order of succession. On the average of three years with a higher level of nitrogen Besostaya took the first place. The number of ears was determined by the number of germinative seeds sown, and was reliably modified by nitrogen fertilization in the first year only, first of all in the variety Fertődi which is inclined to stool even in a dense stand. On the average of the three years ear density was the greatest in the variety Besostaya. As to the number of grains per ear the variety Fertődi was strikingly good. San Pastore showed high ear productivity only in the favourable crop year. The thousand-grain-weight of the varieties ranged between wide limits in the individual years. Regarding the thousand-grain-weight Besostaya was superior to the other two varieties every year.

On the average of the years a 6 cm depth of sowing proved to be the best. In the winter of 1962—63 sowing depth even affected overwintering in the

Table 4

Three years' summarized variance table

Cause of variability		Degree of independence	Grain yield	Ear/m²	Grain/ear	Thousand-grain-weight
			MQ			
Years	(É)	2	14 574.58	181 138.50	308 800	11 273.74 ***
Blocks	(B)	8	61.52	223.00	12 426	99.66 ***
É × B		16	13.98	199.88	7 614	37.56 **
Main lots						
Soil cultivation	(T)	2	39.24 *	212.00 NS	1 944 NS	66.42 *
Variety	(F)	2	288.87 NS	5 282.00 NS	112 834 *	1 880.71 NS
T × F		4	17.35 NS	557.25 *	2 450 NS	10.05 NS
Depth of sowing	(V)	2	21.12 NS	318.00 NS	2 402 NS	21.89 NS
T × V		4	8.87 NS	64.50 NS	354 NS	19.67 NS
F × V		4	2.09 NS	193.75 NS	680 NS	16.67 NS
Number of germs	(C)	2	22.88 NS	12 856.50 ***	30 870 ***	207.21 ***
T × C		4	3.52 NS	82.50 NS	5 478 *	18.94 NS
F × C		4	6.78 NS	399.50 NS	1 602 NS	5.32 NS
V × C		4	34.11 *	239.25 NS	2 373 NS	56.48 *
Time of sowing	(I)	2	110.22 ***	549.00 NS	6 787 NS	21.76 NS
i (T × I)		2	33.28 ?	10.00 NS	795 NS	23.36 NS
F × I		4	3.04 NS	61.25 NS	1 505 NS	28.72 NS
V × I		4	10.27 NS	546.25 *	2 615 NS	9.43 NS
C × I		4	6.10 NS	323.25 NS	2 074 NS	8.24 NS
Years × main lots						
É × I		4	18.44 NS	422.00 ?	4 983 *	12.10 NS
É × F		4	327.67 ***	26 449.50 ***	15 300 ***	975.97 ***
É × T × F		8	5.64 NS	207.62 NS	2 343 NS	13.51 NS
É × V		4	23.69 NS	113.00 NS	3 824 NS	37.40 *
É × T × V		8	10.73 NS	238.88 NS	2 094 NS	13.86 NS
É × F × V		8	9.37 NS	80.12 NS	1 489 NS	8.39 NS
É × C		4	2.17 NS	256.50 NS	3 528 NS	31.61 ?
É × T × C		8	5.79 NS	100.75 NS	2 776 NS	3.97 NS
É × F × C		8	5.28 NS	386.75 *	1 700 NS	12.31 NS
É × V × C		8	8.51 NS	170.62 NS	3 378 ?	5.79 NS
É × I		4	24.34 NS	767.50 **	11 191 ***	78.66 ***
É × é (T × I)		4	5.48 NS	159.00 NS	1 162 NS	8.93 NS
É × F × I		8	28.80 *	488.38 *	2 356 NS	30.00 *
É × V × I		8	20.73 NS	301.62 NS	1 152 NS	10.99 NS
T × C × I		8	7.86 NS	431.12 *	4 920 *	25.13 NS
"a"-error		72	12.48	183.83	1 808	14.28

Cause of variability	Degree of independence	Grain yield	Ear/m²	Grain/ear	Thousand-grain-weight
		MQ			
Sub-plots					
Nitrogen fertilization (N)	2	1 946.96 *	1 384.50 NS	585 917 **	28.26 NS
T × N	4	4.61 NS	229.50 NS	342 NS	0.54 NS
F × N	4	15.92 *	335.25 NS	1 894 NS	67.19 NS
V × N	4	0.89 NS	128.00 NS	805 NS	1.08 NS
C × N	4	1.21 NS	79.25 NS	1 072 NS	1.28 NS
I × N	4	1.17 NS	218.50 NS	1 421 NS	0.91
Time of fertilization (without sham treatments) (M)	2	6.30 NS	489.50 **	1 047 NS	12.29 ***
T × M	4	0.90 NS	95.75 NS	942 NS	0.97 NS
F × M	4	0.73 NS	148.50 NS	734 NS	5.62 **
V × M	4	0.61 NS	366.50 *	1 184 NS	1.04 NS
C × M	4	0.40 NS	7.75 NS	343 NS	1.96 NS
I × M	4	0.45 NS	66.25 NS	292 NS	2.84 NS
N × M (without sham treatments)	2	1.88 NS	25.00 NS	67 NS	0.05 NS
Years × sub-plots					
É × N	4	221.25 ***	542.75 ***	17 311 ***	19.70 ***
É × T × N	8	11.32 ***	58.50 NS	1 900 **	3.60 ?
É × F × N	8	3.88 ***	501.75 ***	5 364 ***	29.90 ***
É × V × N	8	0.36 NS	25.50 NS	920 NS	2.15 NS
É × C × N	8	3.14 **	18.50 NS	1 190 ?	1.23 NS
É × I × N	8	3.64 ***	173.00 *	1 291 *	0.80 NS
É × M	4	15.46 ***	110.25 NS	1 186 ?	2.72 NS
É × T × M	8	0.74 NS	124.25 NS	705 NS	1.03 NS
É × F × M	8	0.56 NS	51.75 NS	1 335 *	0.83 NS
É × V × M	8	0.63 NS	28.88 NS	656 NS	0.89 NS
É × C × M	8	1.65 ?	43.00 NS	412 NS	1.54 NS
É × I × M	8	0.71 NS	83.75 NS	269 NS	0.60 NS
É × N × M	4	1.16 NS	91.00 NS	219 NS	2.11 NS
Among sham treatments	492	0.94	78.95	573	1.52
"b"-error	1314	0.89	84.70	630	1.43

*** = significant at the probability level of P = 0.1%
** = significant at the probability level of P = 1%
* = significant at the probability level of P = 5%
NS = non significant

Table 5

Table of results of common effects on the average of three years (1960/61, 1961/62 and 1962/63)

Factor	Grain yield		Ear/m²		Grain/ear		Thousand-grain-weight	
	kg/ha	%	no.	%	no.	%	g	%
Factors of main plots								
Soil cultivation (T)								
shallow (disc)	3432	100	497	100	21.77	100	40.32	100
medium (20 cm) ploughing	3339	97	493	99	21.45	98	39.98	99
deep (25 cm) ploughing	3271	95	502	101	21.55	99	39.73	98
S.d. P = 5%	129		12.3		1.03		0.40	
Variety (F)								
Fertődi 293	3509	100	490	100	22.49	100	40.05	100
Besostaya 1	3434	98	525	107	20.17	90	41.60	104
San Pastore	3098	88	477	97	22.10	98	38.39	96
S.d. P = 5%	914		148.1		1.80		4.54	
Depth of sowing (V)								
4 cm	3282	100	499	100	21.80	100	39.83	100
6 cm	3398	104	503	101	21.47	98	40.17	101
8 cm	3361	102	491	98	21.50	99	40.03	100
S.d. P = 5%	129		12.3		0.45		0.89	
Number of germs (C)								
Fert. Bes. SP.								
4.52 5.04 6.43 mil/ha	3410	100	465	100	22.29	100	40.58	100
5.04 5.56 6.95 ,,	3287	96	491	106	21.46	96	39.94	98
5.56 6.08 7.47 ,,	3345	98	537	115	21.01	94	39.52	97
S.d. P = 5%	129		12.3		0.45		0.40	
Time of sowing (I)								
1960. 1961. 1962.								
1. 20 Oct. 2 Nov. 11 Oct.	3459	100	502	100	21.94	100	40.19	100
2. 27 Oct. 4 Nov. 23 Oct.	3385	98	501	100	21.41	98	39.84	99
3. 4 Nov. 10 Nov. 5 Nov.	3197	92	489	97	21.41	98	40.00	99
S.d. P = 5%	129		25.2		1.54		1.29	

Factor	Grain yield		Ear/^{2}		Grain/ear		Thousand-grain-weight	
	kg/ha	%	no.	%	no.	%	g	%
Factors of sub-plots								
Nitrogen (N)								
0	2697	100	484	100	18.34	100	39.94	100
87 kg/ha N	3598	133	504	104	22.86	125	40.23	101
174 kg/ha N	3747	139	504	104	23.56	128	39.86	100
S.d. P = 5%	752		29.5		1.91		0.64	
Time of fertilization (M)								
Autumn	3329	100	500	100	21.58	100	40.19	100
Winter	3333	100	490	98	21.52	100	39.87	99
End of winter	3379	101	502	100	21.67	100	39.97	99
S.d. P = 5%	199		8.2		0.26		0.13	

In the crop year of 1962/63 fertilizer doses planned to be distributed during the winter were applied in spring in two parts.

variety San Pastore which was shown by a 32 percent surplus grain yield as compared to stands sown less deep.

Changes in the number of germs resulted in no significant grain yield differences either in the same year or on the average of the three years. Moreover, on the average of both years and varieties the lowest number of germs resulted in the highest yield — though by low and not reliable surpluses. Accordingly, 432 germs of the variety Fertődi, 504 of the Besostaya and 643 germs per m^2 of the San Pastore were sufficient to develop the optimum stand density. On the average of the years the lowest number of germs mentioned resulted in 457 ears in the variety Fertődi, 480 in Besostaya and 458 in San Pastore per m^2, and these ear densities gave maximum grain yields. Though the number of ears grew proportionally with the increased number of germs, at the same time ear productivity and thousand-grain-weight decreased.

On the average of three years stands sown relatively early yielded 262 kg/ha more grains than that sown the latest, which proves the great importance of the optimum time of sowing in the case of intensive varieties as well.

Each year, and also on the average of the years nitrogen application was the most efficient of all factors examined in increasing the grain yield. On the average of both the three years and all the other factors, 87 kg/ha N-active agent resulted in 33 percent (901 kg/ha) and 174 kg/ha N-active agent in 39 percent (1050 kg/ha) grain yield surplus.

Nitrogen application increased reliably the ear number of the variety Fertődi only in the first year, while productive stooling in the varieties Beisostaya and San Pastore was insignificant every year. Nitrogen applicaton increased in each case the productivity of ears, that is, the ears developed more grains. In all the three varieties the decisive proportion of the surplus grain yield resulted from the increased number of grains per ear. Thousand-grain-weight was a function of variety and season, and was not significantly modified by the nitrogen fertilization.

Among the agrotechnical factors examined, the time of nitrogen application affected the amount of yield to the lowest extent. Its influence was practically insignificant. Ear density and ear productivity were not reliably modified by the time of nitrogen application either.

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INHERITANCE OF EARLINESS AND PLANT HEIGHT IN A TWELVE-PARENT DIALLEL CROSS OF UPLAND JUTE

By

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The inheritance of earliness and plant height was studied in a 12-parent diallel cross of *Corchorus olitorius* L. using F_1 data. For earliness, the varieties C.G., 0–5, Desimasua, 0–753, Chinese *olitorius* and R-26 showed the presence in majority of recessive genes, whereas the varieties 0–632, 0–6E, Wild *olitorius* Assam and *Olitorius* Coembator that of dominant genes. For plant height, the varieties 0–632, 0–6E, Wild *olitorius* Assam, *olitorius* Coembator and Chittagong wild jute contained more dominant genes, whereas C.G., 0–753, 0–5, Desimasua and R-26 were in excess of recessive genes. On an overall basis, earliness and plant height were found to be controlled by both dominant and recessive genes. While the contribution to plant height of dominant and recessive genes was equal, the contribution to earliness of dominant genes was more than that of recessive genes. Five dominant effective factors were found to control earliness, whereas eighteen and twenty-one dominant factors were involved in conditioning plant height. Transgressive segregation has been indicated for plant height in the array 9, where Wild jute is the recurrent parent and for earliness in the arrays 2, 3, 6 and 8 where C.G., 0–753, Chinese olitorius and R. 26 are respectively recurrent parents. Heritability was calculated for earliness to be 53% in 12-parent and 66% in 9-parent analysis, whereas it was determined for plant height, to be 21% in 12-parent and 35% in 8-parent analysis.

Introduction

Jute is an important cash crop of Pakistan. Considerable genetic studies have been made on the qualitative character of the crop, but very little is known about the inheritance of its quantitative character. Most of the economic characters are, however, quantitative in nature and in order to execute successful breeding programmes for the improvement of such characters, it is essential to acquire information about the mode of their inheritance.

The quantitative character is controlled by polygenes, but the effects of such an individual gene are too small to be recognized and evaluated separately. Statistical methods have been developed to deal with the average effects of these genes (Fischer 1918, Fischer–Immer–Tedin 1932, Mather 1949, Anderson–Kempthorne 1954, Cockerham 1954, Jinks 1954, Hayman 1954, Hayman–Mather 1955, Hayman 1958). Diallel cross analysis is one of the statistical methods developed and used to find out the breeding value of parents for the character controlled by polygenes in both self- and cross-pollinated plants (Hayman 1954, Jinks 1954, Johnson–Aksel 1959, Cooke–Mather 1962). Diallel cross study involves the first filial generation with or without the parents. A review of publications in the field reveals that biometrical techniques for diallel cross analysis are efficient means of obtaining a rapid overall picture of the genetical control of quantitative characters in a number of inbred lines. These techniques also throw light on the genetical basis of heterosis in F_1 progeny of these lines (Hayman 1954, 1957, Hayman—Mather 1955, Jinks 1954, 1955, Johnson—Aksel 1959, Aksel—Johnson 1961, Eunus—Johnson—Aksel 1962, Cooke—Mather 1962, Johnson—Eunus 1964, Hill 1964). Considering that genetical studies of quantitative characters may be useful in executing successfully the breeding programme for the improvement of jute, the present study on "inheritance of earliness and plant height in a twelve-parent diallel cross of upland jute (*Corchorus olitorius* L)" was undertaken.

Material and Method

Twelve varieties of *Corchorus olitorius* were selected for the study. The following pure seeds of the varieties were supplied by Pakistan Central Jute Research Institute:

1.	0—632	(late)
2.	C.G.	(early)
3.	0—753	(early)
4.	0—5	(early)
5.	0—6E	(medium-late)
6.	Chinese olitorius	(early)
7.	Desimasua	(medium-late)
8.	R-26	(medium-late)
9.	Wild jute	(late)
10.	Wild olitorius	(late)
11.	Assam Chittagong wild jute	(early)
12.	Olitorius Coembator	(late)

Twelve parents were sown in pots at the end of May, 1965. Crosses were made in all possible combinations without reciprocals, giving a total of 66 cross-progenies. The sixty six F_1 progenies along with twelve parents were randomly assigned to rows in each of three blocks in the field at the advent of the monsoon season in 1966. The space between rows was one foot and that between plants in a row was four inches. There were 61 plants in a row of which 2 plants on either side of each row were treated as non-experimental. The date of flowering was noted for each plant separately. At the time of flowering, plant height was measured in inches from the base to the point of bifurcation occurring due to flowering.

Diallel techniques of Hayman (1954) and Jinks (1954) were usually used to estimate the genetic parameters D, H_1, H_2, h^2 and F as defined by Jinks (1954), who followed the notation of Mather (1949). A standardized deviation graph for the parental measurements and orders of degree of dominance was drawn following the methods of Johnson—Aksel (1959). The single array analysis was based on error equations equivalent to those developed by Jinks (1955) and Aksel—Johnson (1961), as follows:

$$\begin{aligned}
4\,\hat{\mathrm{V}}\mathrm{ar.}\,(\mathrm{d}) + \hat{\mathrm{V}}\mathrm{ar.}\,(\mathrm{e_p}) - \mathrm{Var.}\,\bar{\mathrm{x}}_\mathrm{p} &= \mathrm{E}_1\\
2\,\hat{\mathrm{V}}\mathrm{ar.}\,(\mathrm{d}) + 2\,\mathrm{C\hat{o}v.}\,(\mathrm{d})\,(\mathrm{h}) + 1/\mathrm{n}\,\mathrm{V\hat{a}r.}\,(\mathrm{e_p}) - \mathrm{Cov.}\,\bar{\mathrm{x}}_\mathrm{p}\,\bar{\mathrm{x}}_\mathrm{r} &= \mathrm{E}_2\\
\hat{\mathrm{V}}\,\mathrm{ar.}\,(\mathrm{d}) + 2\,\mathrm{C\hat{o}v.}\,(\mathrm{d})\,(\mathrm{h}) + \mathrm{V\hat{a}r.}\,(\mathrm{h}) + 1/\mathrm{n}\,\mathrm{V\hat{a}r.}\,(\mathrm{e_p})&\\
+ (\mathrm{n} - 1)\,(\mathrm{n}\,\mathrm{V\hat{a}r.}\,(\mathrm{e_0}) - \mathrm{Var.}\,\bar{\mathrm{x}}_\mathrm{r} &= \mathrm{E}_3\\
1/\mathrm{n}\,\mathrm{V\hat{a}r.}\,(\mathrm{e_p}) + (\mathrm{n} - 1)\,(\mathrm{n}\,\mathrm{V\hat{a}r.}\,(\mathrm{e_0}) - \mathrm{Var.}\,(\mathrm{e_r}) &= \mathrm{E}_4\\
1/\mathrm{n}\,\mathrm{V\hat{a}r.}\,(\mathrm{e_p}) - \mathrm{Cov.}\,(\mathrm{e_p e_r}) &= \mathrm{E}_5\\
\mathrm{V\hat{a}r.}\,(\mathrm{e_p}) - \mathrm{Var.}\,(\mathrm{e_p}) &= \mathrm{E}_6
\end{aligned}$$

Each array, including the corresponding self and the set of non-recurrent parents was treated as a separate experiment. In the above equations, (d) and (h) represent respectively the algebraic sums of additive and dominance effects of genes affecting the metric aspects of earliness and of plant height; (e_p), (e_r) and (e_0) are the environmental components of variation in parental, offspring (self included) and offspring (self excluded) arrays; Var. $\bar{x}_p$ and Var. $\bar{x}_r$ are the variances of the means over replications of parental and offspring arrays; Cov. $\bar{x}_p$ $\bar{x}_r$ is the co-variance of the means of parents and offsprings, and Cov. (e_p e_r) is the co-variance of the environmental variations of parents and offsprings; E_i ($i = 1, 2, \ldots 6$) are the corresponding errors. Such a set of six equations with five unknowns based on the parent set and its offsprings from crosses with the same parents (recurrent) was solved individually for each array by the least square methods. E_i^2 multiplied by multipliers for Var. (d), Cov.(d, h), Var. (h), Var. (e_p) and Var. (e_0) provided the respective error variances.

Results

Earliness

General analysis. Variance of each array (V_r) and co-variance between parents and their progenies in each array (W_r) were calculated. The regression coeffecient was estimated and found to be 0.6121 ± 0.0836 (Fig. 1). Thus the regression coefficient differs significantly from zero and from unity, indicating some non-allelic genic interaction. The significant value of t^2 (Lo. 95) also indicated non-fulfilment of some of the postulated assumptions on which the diallel technique of analysis was based.

A parabola, $W_r^2 = V_p V_r$, where V_p is the variance of the parents and V_r is the variance of the rth array, was drawn (Fig. 1). The regression line

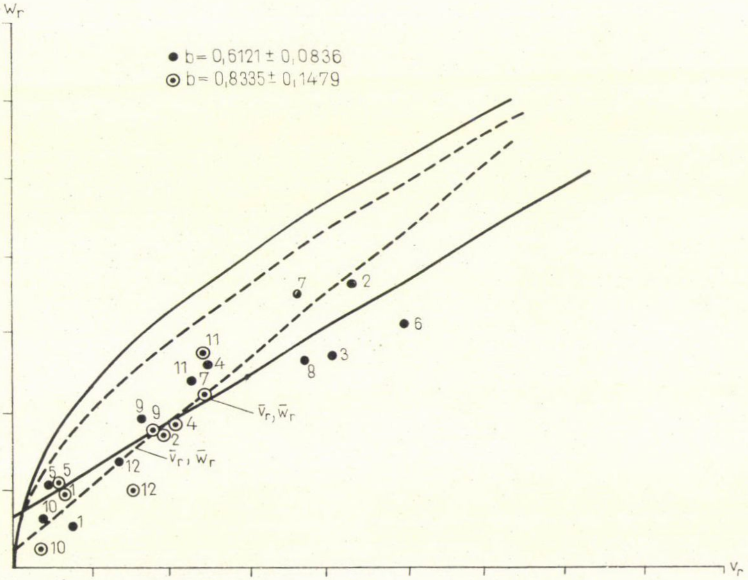

Fig. 1. (W_r, V_r) graphs with regression lines of W_r on V_r for earliness. Continuous lines with solid dots represent 12-parent analysis, whereas broken lines and dots with circle represent 9-parent analysis

drawn through the point (V_r, W_r) passed above the point of origin and deviated significantly from the line of unit slope, indicating the probable presence of complementary genic interaction. As the arrays 2, 6 and 8 showed the highest deviations in ($W_r - V_r$), re-analysis was made, excluding these three arrays. $t^2 = 0.2623$ indicates probable fulfilment of the postulated assumptions on which the diallel technique of analysis was based. Regression coefficient of $b = 0.8335 \pm 0.1479$ also did not differ significantly from unity. The V_r, W_r graph was drawn and the regression line drawn through the point ($\overline{V}_r$, $\overline{W}_r$) passed above the point of origin. Removal of any other array did not improve the b value.

In the examination of the co-ordinate V_r, W_r values, the graph shows that varieties numbered 1, 5, 10 and 12 appeared to possess an excess of dominant genes, whereas varieties 7, 9 and 11 were associated with an excess of recessive genes.

Standardized deviation graphs of parental measurements (Y_r) and orders of degree of dominance ($W_r + V_r$) were drawn (Fig. 2) in order to determine whether dominance and recessiveness were due to an excess of positive or of negative genes. The graphs indicate that dominance was due to an excess of positive genes in all varieties showing dominance, whereas varieties exhibiting an excess of recessive genes generally possessed an excess of negative genes, except for the variety 9 which possessed an excess of positive genes. The coefficient of correlation (r) between the parental measurements (Y_r) and

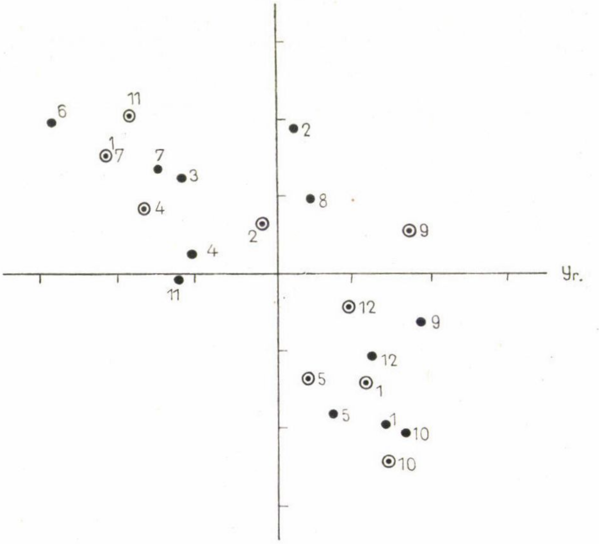

Fig. 2. Standardized deviation graphs of parental measurements (Y_r) and orders of degree of dominance ($W_r + V_r$) for earliness. Solid dots represent 12-parent analysis, whereas dots with circle represent 9-parent analysis

orders of degree of dominance $(W_r + V_r)$ were found to be -0.7479 in 12-parent analysis, and -0.7690 in 9-parent analysis indicating the presence of excess positive dominant genes in parents.

The components of variation and their proportions are given in Table 1. The average degree of dominance was estimated by $(\hat{H}_1/\hat{D})^{1/2}$, $2(V_{ILI}/W_{OLOI}-1/2)$ and by V_{ILI}/W_{OLOI}. In 12-parent analysis $(\hat{H}_1/\hat{D})^{1/2}$ indicated complete dominance, whereas V_{ILI} and W_{OLOI} proportions indicated the presence of overdominance, which was substantiated by a significant difference in $(\hat{D} - \hat{H}_1)$. In 9-parent analysis all the three proportions indicated complete dominance which was confirmed by the non-significant difference in $(\hat{D} - \hat{H}_1)$.

Table 1

Components of variation for earliness

Components of variation			Proportional values		
Notation	Including all arrays	Arrays 3, 6 and 8 excluded	Including all arrays		Arrays 3, 6 and 8 excluded
$\hat{D}$	106.83 ± 4.8303	82.02 ± 1.7233	$(\hat{H}_1/\hat{D})^{1/2}$	1.0569	0.9958
$\hat{F}$	38.88 ± 8.4236	43.60 ± 4.0224	$(\hat{H}_2/4\hat{H}_1)$	0.2040	0.1853
$\hat{H}_1$	127.82 ± 7.4301	81.34 ± 3.8065	$[(4\hat{D}\hat{H}_1)^{1/2} + \hat{F}]/[(4\hat{D}\hat{H}_1)^{1/2} - \hat{F}]$	1.3991	1.7365
$\hat{H}_2$	104.34 ± 6.1846	60.32 ± 3.2741	$\hat{h}^2/\hat{H}_2$	4.2705	0.1681
$\hat{h}^2$	445.59 ± 4.1333	10.14 ± 2.1725	$2(V_{ILI}/W_{OLOI} - ½)$	1.2402	0.9766
$\hat{E}$	1.49 ± 1.0099	1.16 ± 0.5429	V_{ILI}/W_{OLOI}	1.1201	0.9883
$(\hat{D} - \hat{H}_1)$	-19.99 ± 6.1311	6.14 ± 9.7132			

Heritability $-[{}^1/_4\hat{D}/({}^1/_4\hat{D} + {}^1/_4\hat{H}_1 - {}^1/_4\hat{F} + \hat{E})] = 53\%$ in 12-parent and 66% in 9-parent plants

The fraction $\hat{H}_2/4\hat{H}_1$ measures the proportion of genes with positive and negative effects in parents. The value of 0.2040 in 12-parent and that of 0.1853 in 9-parent analysis suggest asymmetry at loci showing dominance. The ratio, $[(4\hat{D}\hat{H}_1)^{1/2} + F] / [(4\hat{D}\hat{H}_1)^{1/2} - \hat{F}]$ measures the proportion of dominant and recessive genes in parents. In the present case, the dominant genes were shown to be in excess, the value for the ratio being 1.3991 and 1.7365, respectively for 12-parent and 9-parent diallels. The significant positive $\hat{F}$ values in both cases provide the same information. The ratio, $\hat{h}^2/\hat{H}_2$ measures the number of groups of genes in parents showing dominance for the character under study. The present value being 4.2705 in 12-parent analysis suggests that at least five groups of dominant genes were involved in conditioning earliness. In 9-parent analysis $\hat{h}^2/\hat{H}_2$ did not provide any information. Heritabilities were determined

Table 2

Result of single array analysis for earliness
Measured from sowing to flowering

Components of variation and ratio	Arrays					
	1	2	3	4	5	6
Var. (d)	26.8156 ±0.7020	26.8213 ±2.6924	26.8050 ±2.4815	26.8272 ±1.6841	26.8255 ±0.6129	26.8126 ±3.0717
Cov. (d, h)	−21.9462 ±1.9579	7.9316 ±7.5094	−0.9899 ±6.9211	−1.5260 ±4.6983	−16.7993 ±1.7096	2.3177 ±8.5673
Var. (h)	28.0803 ±3.4973	34.3482 ±13.4133	47.9112 ±12.3626	17.2286 ±8.3903	11.7788 ±3.0538	56.3304 ±15.3029
Var. (ep)	0.2644 ±1.9827	0.2587 ±7.6042	0.2750 ±7.0082	0.2528 ±4.7586	0.2545 ±1.7317	0.2674 ±8.6754
Var. (e_0)	1.8787 ±2.1778	2.5516 ±8.3526	2.3999 ±7.6982	4.4773 ±5.2247	2.9502 ±1.9016	4.6161 ±9.5289
$[\mathrm{Var.(h)/Var.(d)}]^{1/2}$ ...	1.0262	1.1316	1.3368	0.8013	0.6631	1.4494
$\pm^{\mathrm{r}}$(h)/(d)	−0.7997	0.2615	−0.0276	0.0710	−0.9453	0.1887

Components of variation and ratio	Arrays					
	7	8	9	10	11	12
Var. (d)	26.8156 ±2.2426	26.8168 ±2.6603	26.8181 ±1.1233	26.8225 ±0.5792	26.8212 ±1.5282	26.8208 ±1.0372
Cov. (d. h)	6.7520 ±6.2551	−1.7562 ±7.4871	−7.8798 ±3.1331	−20.5674 ±1.5963	−3.6751 ±4.2624	−13.4403 ±2.8930
Var. (h)	24.4024 ±11.1729	42.6211 ±13.2537	16.2407 ±5.5964	19.7856 ±2.8514	20.4353 ±7.6136	23.2236 ±5.1675
Var. (ep)	0.2644 ±6.3341	0.2632 ±7.5136	0.2619 ±3.1727	0.2575 ±1.6164	0.2588 ±4.3162	0.2592 ±2.9294
Var. (e_0)	2.0252 ±6.9597	2.6984 ±8.2532	1.7160 ±3.4849	1.1564 ±1.7756	1.8130 ±4.7410	1.5540 ±3.2179
$[\mathrm{Var.(h)/Var.(d)}]^{1/2}$ ...	0.9537	1.2606	0.7778	0.8588	0.8728	0.9304
±l(h)/(d)	0.2639	−0.1642	−0.3777	−0.8800	−0.1570	0.5386

with the method of Crumpacker – Allard (1962), and they were found to be 53 and 66%, respectively in 12-parent and 9-parent diallels.

Single array analysis. Results of single array analysis in which the parental sets have been considered separately for each array, are shown in Table 2. It separates Var. (d), Cov. (d, h), Var. (h), error variance for parents (e_p), for offspring (e_0) in each array. The average degree of dominance in each array is measured by the term $[\text{Var. (h)}/(\text{Var. (d)}]^{1/2}$, whereas correlation between Var. (d) and Var. (h) is measured by the term $\pm^{r}(\text{h})/(\text{d})$. Overdominance was indicated in arrays 2, 3, 6 and 8 and partial dominance in the remaining arrays except the array 1 which exhibited complete dominance.

The Cov. (d, h) values indicate that the recurrent parents of the arrays 1, 5, 9, 10 and 12 were associated with an excess of dominant genes, whereas the recurrent parents of the remaining arrays indicated the possession of dominant and recessive genes in equal proportions.

Plant height

General analysis. The V_r and W_r values together with their regression coefficient were calculated for all the 12 arrays and the (V_r, W_r) graph was drawn (Fig. 3). The regression line passed above the point of origin and deviated

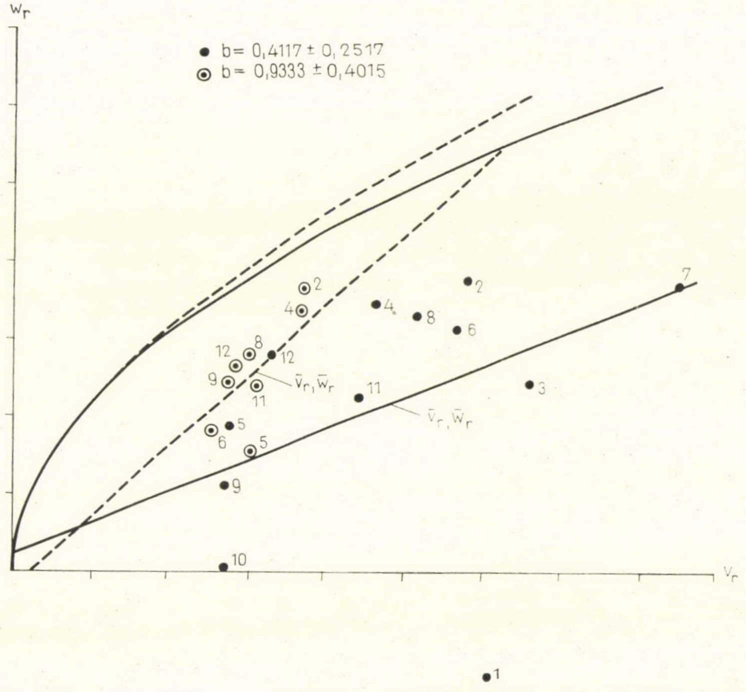

Fig. 3. (W_r, V_r) graphs with regression lines of W_r on V_r for plant height. Continuous lines with solid dots represent 12-parent analysis, whereas broken lines and dots with circle represent 8-parent analysis

significantly from the unit slope indicating the presence of complementary genic interaction. As most significant deviations in $(W_r - V_r)$ occurred in the arrays 1, 3, 7 and 10, re-analysis was made, excluding these four parents and their progenies. The regression coefficient of $b = 0.9333 \pm 0.4015$ did not differ from unity. The regression line drawn through the point $(\overline{V}_r, \overline{W}_r)$, passed below the point of origin. Removal of any other array did not improve the b value.

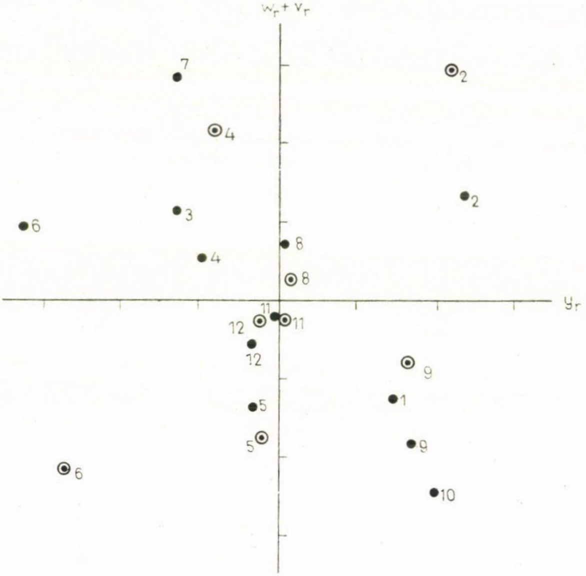

Fig. 4. Standardized deviation graphs for plant height. Solid dots represent 12-parent analysis, whereas dots with circle represent 8-parent analysis.

Examination of the co-ordinate V_r, W_r values in the graphs shows that the varieties numbered 5, 9, 11 and 12 showed an excess of dominant genes and the varieties 8, 4 and 2 exhibited an excess of recessive genes.

The standardized deviation graph of parental measurements (Y_r) and parental orders of dominance $(W_r + V_r)$ indicates that dominance in the varieties 5, 11 and 12 was due to an almost equal proportion of positive and negative excess dominant genes, recessiveness in the variety 8 was due to an equal proportion of negative and positive excess recessive genes, whereas recessiveness in 2 and 4 was due to an excess of positive and of negative recessive genes, respectively. The variety 9 possessed excess positive dominant genes (Fig. 4).

The correlation coefficient (r) between the parental measurements (Y_r) and the parental orders of dominance $(W_r + V_r)$ were found to be -0.5196 and -0.5283, respectively in 12-parent and 8-parent analysis indicating the presence of an equal proportion of positive and negative dominant genes in parents.

The components of variation and their proportions are given in Table 3. In 12-parent analysis, all the three proportions, $(\hat{H}_1/\hat{D})^{1/2}$, $2(V_{ILI}/W_{OLOI} - 1/2)$ and (V_{ILI}/W_{OLOI}) indicated overdominance which was supported by a significant difference in $(\hat{D} - \hat{H}_1)$. After the removal of the four arrays showing highest deviations in $(W_r - V_r)$, all the three proportions indicated more or less complete dominance. A non-significant difference between $\hat{D}$ and $\hat{H}_1$ provided the same information.

Table 3

Components of variation for plant height

Components of variation			Proportional values		
Notation	Including all arrays	Arrays 1, 3, 7 and 10 excluded	Including all arrays		Arrays 1, 3, 7 and 10 excluded
$\hat{D}$	0.87 ± 0.1261	0.94 ± 0.0243	$(\hat{H}_1/\hat{D})^{1/2}$	1.8083	1.1577
$\hat{F}$	0.06 ± 0.2199	−0.08 ± 0.1825	$(\hat{H}_2/4\hat{H}_1)$	0.2140	0.1984
$\hat{H}$	2.85 ± 0.1940	1.26 ± 0.1774	$[(4\hat{D}\hat{H}_1)^{1/2} +]\hat{F}/[(4\hat{D}\hat{H}_1)^{1/2} - \hat{F}]$	1.0389	0.9288
$\hat{H}_2$	2.44 ± 0.1615	1.00 ± 0.1543	$\hat{h}^2/\hat{H}_2$	20.7131	17.2300
$\hat{h}^2$	50.54 ± 0.1079	19.23 ± 0.1008	$2(V_{ILI}/W_{OLOI} - 1/2)$	3.2324	1.2000
$\hat{E}$	0.10 ± 0.0263	0.10 ± 0.0252	V_{ILI}/W_{OLOI}	2.1162	1.1000
$(\hat{D} - \hat{H}_1)$	−1.39 ± 0.1612	−0.32 ± 0.4576			

Heritability $[{}^1/_4\hat{D}/({}^1/_4\hat{D} + {}^1/_4\hat{H}_1 - {}^1/_4\hat{F} + \hat{E})] = 21\%$ in 12-parent and 35% in 8-parent plants

The values for $\hat{H}_2/4\hat{H}_1$ obtained in both 12-parent and 8-parent analysis, suggest asymmetry in the distribution of dominant alleles at all loci. The values of ratio, $[(4\hat{D}\hat{H}_1)^{1/2} + \hat{F}])$ $[(4\hat{D}\hat{H}_1)^{1/2} - \hat{F}]$ equal to 1.0389 and 0.9288 suggest an equal proportion of dominant and recessive genes conditioning the plant height in the both cases. The non-significant $\hat{F}$ values provide similar information. The ratio, $\hat{h}^2/\hat{H}_2$ equal to 20.7131 and 17.2300 suggests that twenty-one and eighteen dominant factors were involved in conditioning plant height, respectively in 12-parent and 8-parent diallels. The heritability for plant height was found to be 21 and 35%, respectively in 12-parent and 8-parent diallels.

Single array analysis. The results of single array analysis are given in Table 4. The degree of dominance as measured by $[\text{Var. (h)}/(\text{Var. (d)}]^{1/2}$ for each array indicates that arrays 1, 9 and 10 exhibited dominance, whereas all other

Table 4

Result of single array analysis for plant height
Measured from the base to the point of bifurcation due to flowering

Components of variation and ratio	Arrays											
	1	2	3	4	5	6	7	8	9	10	11	12
Var. (d)	0.2163	0.2160	0.2175	0.2157	0.2159	0.2172	0.2164	0.2152	0.2154	0.2159	0.2151	0.2152
	±0.0590	±0.0536	±0.0707	±0.0474	±0.0440	±0.0625	±0.0532	±0.0514	±0.0440	±0.0468	±0.0528	±0.0458
Cov. (d, h)	−0.3829	0.1321	−0.0146	0.1091	−0.0446	0.0569	0.1061	0.0961	−0.1153	−0.2293	−0.0049	0.0538
	±0.1646	±0.1495	±0.1974	±0.1324	±0.1217	±0.1743	±0.1485	±0.1436	±0.0714	±0.1305	±0.1472	±0.1279
Var. (h)	1.4501	0.4569	0.7185	0.2823	0.1700	0.5895	0.4173	0.4270	1.0201	1.1037	0.3208	0.0995
	±0.2941	±0.2672	±0.3524	±0.2364	±0.2174	±0.3114	±0.2654	±0.2595	±0.2195	±0.2332	±0.2630	±0.2285
Var. (e_p)	0.0262	0.0265	0.0250	0.0268	0.0266	0.0253	0.0261	0.0273	0.0271	0.0266	0.0274	0.0273
	±0.1667	±0.1514	±0.1973	±0.1340	±0.1232	±0.1765	±0.1504	±0.1454	±0.1244	±0.1322	±0.1491	±0.1295
Var. (e_0)	0.2303	0.1456	0.3111	0.1670	0.2270	0.1118	0.2210	0.1380	0.2149	0.1562	0.3107	0.2132
	±0.1831	±0.1663	±0.2194	±0.1472	±0.1353	±0.1939	±0.1652	±0.1597	±0.1367	±0.1452	±0.1638	±0.1423
[Var. (h)/Var. (d)]$^{1/2}$	2.5892	...	...	...	...	...	...	...	2.1761	2.2609	...	...
$\pm\,^{r}$(h)/(d)	−0.6837	0.4205	−0.0369	0.4422	−0.2328	0.1590	0.3530	0.3170	−0.2459	−0.4706	−0.0186	0.3677

arrays showed no dominance. Cov. (d, h) values suggest the presence of an excess of dominant genes in the array 1, whereas the recurrent parents of the remaining arrays possessed an equal proportion of dominant and recessive genes.

Low values of correlation between Var. (d) and Var. (h) in all arrays indicated varying degrees of dominance. A high degree of dominance with corresponding low correlation value between Var. (d) and Var. (h) in the array 9 suggests that transgressive segregation may be expected in the progenies of the array.

Discussion

Regression lines drawn in the (V_r, W_r) graphs indicated an average partial dominance for earliness in 9-parent analysis, whereas overdominance was suggested for plant height in 8-parent analysis. $(\hat{H}_1/\hat{D})^{1/2}$, V_{ILI}/W_{OLOI} and $^2(V_{ILI}/W_{OLOI} - {}^1/_2)$ values, however, suggested the presence of complete dominance in both cases. The non-significant $(\hat{D} - \hat{H}_1)$ values confirmed this inference. The deviation of regression lines from the point of origin was a spurious one and accounted for by a sampling error. The deviation of the regression line from the unit slope and the convex appearance of parabola near the point of origin suggest the presence of a complementary type of epistasis (Hayman 1957, Hill 1964). The removal of arrays showing significant $(W_r - V_r)$ deviations brought the regression line close to the line of unit slope, but could not possibly remove all non-allelic interactions. Large standard error of regression coefficient gives such indication. Eunus (1969) has noted preponderance of complementary type of epistasis in the inheritance of earliness of jute.

Examination of the standardized deviation graphs indicates that, for earliness, all arrays showing dominance possessed an excess of positive genes and flowered later, whereas arrays showing recessiveness possessed an excess of negative genes and flowered earlier. Exception was met within the array 9, which flowered late, though it indicated possession of excess of recessive genes in 9-parent analysis. With respect to the plant height, dominance in some arrays was due to positive genes and in some other arrays it was due to negative genes. Hence some of the arrays showing dominance produced tall plants, whereas some other arrays produced short plants. For a similar reason, some of the arrays exhibiting recessiveness produced short plants, whereas some other arrays produced taller plants.

$\hat{h}^2/\hat{H}_2$ value indicated that five dominant effective factors were involved in conditioning earliness. Eunus (1969) noted that six dominant factors were involved, while Joarder—Eunus—Rahman (1969) detected only one dominant factor. Ghosh—Sharma (1965) reported that the flowering date in *C.*

capsularis was conditioned by three pairs of genes. Plant height, on the other hand, was found to be affected by twenty-one and eighteen dominant effective factors, respectively in 12-parent and 8-parent analysis. JOARDER—EUNUS—RAHMAN (1969) were table to detect eleven dominant effective factors affecting plant height in jute. As the present investigation includes more varieties, more gene differences affecting plant height may be involved.

Some transgressive segregation (plus and minus) is expected in any array that shows overdominance and low correlation between Var. (d) and Var. (h) in the single array analysis. On these grounds, transgressive segregation may be expected for plant height in the array 9 with Wild jute as the recurrent parent, whereas it is expected for earliness in the arrays 2, 3, 6 and 8 where C.G., 0—753, Chinese olitorius and R-26 are respectively recurrent parents. JOARDER—EUNUS—RAHMAN (1969) report that transgressive segregation is expected in the arrays where R-26 and Chinese olitorius were recurrent parents.

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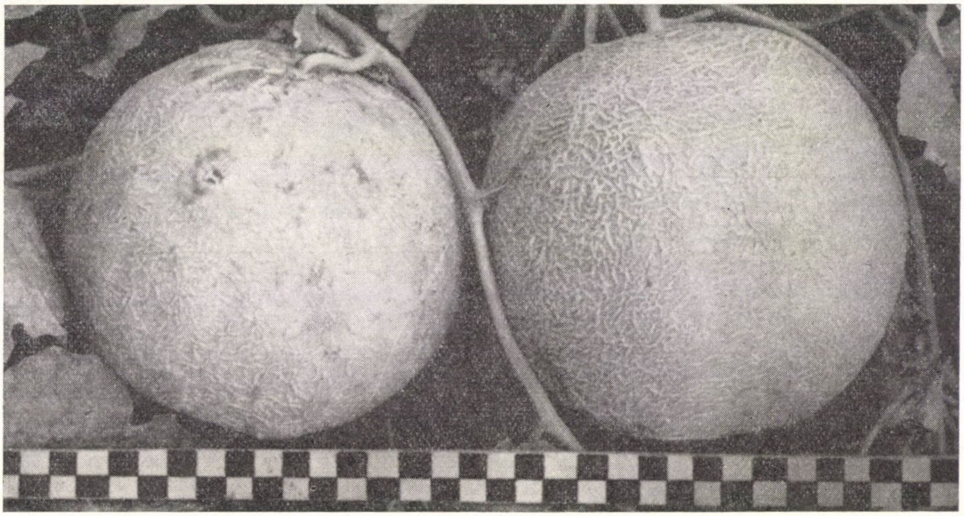
VARIA



"MAGYARKINCS" MUSK-MELON

Taxonomical place: *Cucumis melo* L. ssp. *melo* MSF.
Origin: produced from the local variety "Jászkincs" by individual selection (TUZA 1968).
Beginning of breeding: 1948.
State qualification: state registered improved variety, 1964; first accepted 1956.
Breeder: Antal Ács dr., Debrecen-Kismacs.
General characterization: the best quality early green fleshed musk-melon variety with high productivity.
Morphological description:
- *Root system:* widely spreading, dense; after transplanting the variety takes root readily.
- *Shoot system:* branching, recumbent, moderately developed.
- *Stem:* relatively thin, moderately developed.
- *Foliage:* leaf blade of medium size and yellowish green colour.
- *Flowers:* corolla lemon coloured.
- *Fruit:* spherical (non-costate), with finely tanned surface, and an average weight of 1 kg when ripe; colour dark green when unripe and yellowish green when ripe (it is then that the tan coating appears). Its flesh is green and melting, lighter greenish round the centre. The central cavity is scantily filled with the placenta and seeds. The flesh is thick, sweet, of very good taste. The rind is thin (therefore does not tolerate transporting).
- *Seed:* ivory, oblong elliptic shaped; thousand-grain-weight 26 g.

Biological character:
- *Germination:* cardinal points of germination: minimum 12° C, optimum 25° C, maximum 40° C. Germination is more favourable in the dark.

Vegetation period: 93—113 days from germination to first picking (sometimes as many as 120 days) (KOMJÁTI 1964, TUZA 1968); male flowering takes place in mid-June, female flowering toward the end of June. Growth rate medium. Ripens very early.

Water requirement: medium.

Resistance to disease: fairly good; nevertheless in cold and rainy weather peronospora and anthracnose occur.

Farm technology requirement:

Seeding: into hot-beds in the first half of April, transplantation in the first half of May.

Soil requirement: gives high yields in fertile soil, otherwise is not particular about soil.

Productivity: 150—180 q/ha, of which about 76 percent is faultless; the dry matter content of the flesh is 9—11 percent; productivity generally good (KAPÁS *et al.* 1965).

Region of cultivation: it can be grown in the whole territory of Hungary, mostly for household consumption and local markets.

*

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PLANT BIOMASS PRODUCTION OF MAIZE GROWN ON A FOREST—STEPPE AREA

Plant biomass- and primary production studies carried out in a model area at Újszentmargita (the northern border of Hortobágy) within the framework of the International Biological Program (IBP) cover not only natural and semi-natural plant stands but also those planted in such environment. Thus following examinations were performed in 1967 in a wheat stand and during 1969 assessing and evaluation for similar purposes and with similar methods were made in maize stands.

We do not give a general characterization of arables established on former woodlands, only refer to the related description by MÁTHÉ—PRÉCSÉNYI (1968).

The maize was sown on the 28th April 1969 ("Zöldmező" Cooperative Farm, Újszentmargita). In the previous year wheat had been sown into the parcel with a cabbage second crop after the harvest. Since 1963 the parcel had not been fertilized. The spacing of the maize variety "Szegedi 71" sown was 60 × 30 cm. Germination was uneven, development poor, and here and there the stand was thin. The average yield harvested from the parcel was 15 q/cad. yoke shelled May maize.

Samples were taken of plants sown (maize) as shown in Table 2; 10 plants per month were uprooted. The height and dry weight of each plant were measured. (Dry weight was determined in every case after drying the plant at 105° C.) The underground plant parts were washed out of a soil monolith of 1 dm^3 size (without separating them into living and dead parts). Information on the weed conditions was given by the dry weight of a plant biomass collected on a soil surface of 400 cm^2. Weed seed conditions of the soil were disclosed by the number of weed seeds washed out of monoliths taken from a depth of 10 cm.

Table 1

Dry weight of aboveground parts of a weed biomass, and the number of weed seeds

Time of sample taking	Aboveground parts*		Underground parts*		Number of weed seeds**	
	$g/400\ cm^2$	$g/1\ m^2$	$g/400\ cm^2$	$g/1\ m^2$	per 1 dm^3	per 1 m^2
April 19, 1969	1.2	30.0	10.5	262.5	239	23.900
June 20, 1969	1.7	42.5	5.7	142.5	241	24.100
Sept. 26, 1969	2.0	51.0	6.4	160.0	256	25.600

* Average of 8 samples
** Average of 4 samples

Table 2

Increase of average height and weight in maize
Újszentmargita, 1969

Time	Height (cm)		Dry weight (g)			
			Aboveground		Underground*	
	mean	limit values	mean	limit values	mean	limit values
May 20, 1969	25	(18–30)	0.3		0.06	
June 20, 1969	66	(33–95)	5.2	(0.5–13.6)	1.2	(0.1— 2.7)
July 16, 1969	112	(53–187)	47.9	(2.3–145.0)	13.4	(0.4—45.0)
August 21, 1969	162	(106–241)	192.0	(40.0–510.0)	19.3	(2.0—40.0)
Sept. 26, 1969	164	(120–240)	315.0	(100.0–570.0)	20.3	(10.0—40.0)
Oct. 22, 1969	155	(120–180)	290.0	(140.0–470.0)	25.3	(16.0—30.0)

* Only part of the roots, from a depth of 10–15 cm (dug out a spit deep)
** Averages of only 3 samples

The maize parcel examined generally showed signs of extensive cultivation concerning both sowing and cultural practices. Data on weeds collected on three occasions are shown in Table 1. As it can be seen, the aboveground phytomass had grown steadily until autumn. The large volume of biomass of underground plant parts found in April can be explained by the fact that in the autumn after the wheat, feed cabbage had been grown in this parcel, and at the time of assessing in April the root residues were still in the soil; ploughing and sowing of the maize took place only later.

The number of weed seeds per unit area as seen also in Table 1, does not make any essential distinction between spring, summer and autumn conditions possible. The reason why the rhythm of the weed seed reserves was different than in the same parcel sown with wheat is that hoeing in the maize parcel at that depth modifies and to some extent equalizes the distribution of seed reserves.

Table 3

Data of 10 maize plants selected at random
Újszentmargita, September 26, 1969

	Height cm	Whole above-ground dry	Plant under-ground weight g	Stalk weight g	Weight of leaves g	Weight of ears g	Ear length cm	Cob weight g	Shell weight g	Row of grains	Grain number	Grain weight g
1	190	545.0	40.0	95.0	60.0	390.0	21	50.0	40.0	22	1110	300.0
2	201	530.0	30.0	100.0	70.0	360.0	21	40.0	50.0	18	841	270.0
3	180	535.0	24.0	100.0	65.0	370.0	18	50.0	35.0	16	730	285.0
4	240	670.0	40.0	210.0	100.0	360.0	23	60.0	60.0	18	780	240.0
5	150	220.0	15.0	35.0	25.0	160.0	17	30.0	20.0	12	431	110.0
6	152	140.0	10.0	20.0	20.0	100.0	16	30.0	30.0	12	203	40.0
7	130	135.0	12.0	40.0	25.0	70.0	9	20.0	25.0	12	71	25.0
8	145	165.0	10.0	25.0	25.0	115.0	15	25.0	20.0	12	366	70.0
9	120	120.0	10.0	40.0	20.0	60.0	10	20.0	30.0	8	27	10.0
10	135	135.0	12.0	25.0	15.0	95.0	14	30.0	30.0	11	133	35.0
Mean	164	319.5	20.3	69.0	42.5	208.0	16	35.0	34.0	14	469	138.5

It was with individual plants representing the average stand per unit area and not with a plant biomass harvested from the unit area that measurements were made.

Table 2 shows the uneven growth of the stand well with considerable fluctuations in the height and weight values.

Table 3 illustrates the high fluctuation of the values also observed in relation with the individual plant parts.

The results of the individual weighings were related to m^2, so further data can be compared with those in the literature. Ovington—Heitkamp—Lawrence (1963) and Medina—Lieth (1964) performed production studies on maize. Ovington—Heitkamp—Lawrence carried out investigations in 1959 in Central Minnesota (C-M) with the variety Kings Cross Hybrid K-5-3. Sowing took place on the 19th of May at a spacing of 20 × 90 cm. The authors present their results on the basis of measurements performed on 20 plants. Medina—Lieth sowed the variety "Inra 258" in Stuttgart—Hohenheim (S—H; the abbreviation of Újszentmargita is: UM) on the 20th April, 1963 at a spacing of 75 × 20 cm. Samples were taken per unit area and Atrazin used as herbicide. Of the three different maize stands the data of C-M can hardly be used, as it was sown a month later than the two European maize stands. Yields in UM and those in S-H were nearly identical (Table 4). No further conclusions can, however, be drawn from this, since it was only a single occasion, and might be a coincidence. Westlake (1963) mentioned 2.5—3.6 kg/m^2 dry weight as the maximum biomass of maize. The first one of these data originated from Minnesota, where Ovington and his co-workers worked and found only 0.8 kg/m^2 maximum weight. However, in contrast with the two mentioned maxima, it was not in a plant growing experiment that OVINGTON and his co-workers performed their measurements. Results obtained in UM and S-H are also very near to WESTLAKE's data.

Table 4

Dry weight of maize (g/m^2)

Újszentmargita				Stuttgart-Hohenheim				Central Minnesota			
Time of sample taking		Above-ground parts a)	Under-ground parts b)	Time of sample taking		Above-ground parts a)	Under-ground parts b)	Time of sample taking		Above-ground parts a)	Under-ground parts b)
May	20	2.4	0.5	May	14	0.2	—	—		—	—
June	20	41.6	9.6	June	26	71.6	13.9	June	12	1.8	0.8
July	16	383.2	107.2	July	19	782.6	52.6	July	14	188.1	90.2
August	21	1536.0	154.4	August	14	1220.2	91.0	August	20	586.3	62.8
Sept.	26	2520.0	162.4	Sept.	27	2100.7	94.8	Sept.	10	843.7	58.9

Table 5

Productivity of maize

g/m^2/day

Period between dates of sample taking	Újszentmargita	Stuttgart-Hohenheim	Central Minnesota
a)			
May—June	1,264	1,660	—
June—July	13,136	30,913	5,790
July—August	31,152	16,880	10,756
August—September	27,328	22,284	12,257
Vegetative season average:	19,534	15,444	9,354
b)			
May—June	1,558	1,983	—
June—July	16,892	32,566	8,615
July—August	33,333	18,307	10,021
August—September	27,555	20,098	12,071
Vegetative season average:	20,771	16,141	10,000

a) aboveground parts; *b)* underground parts

UM and S-H (Table 5) are different in productivity. As to the aboveground parts in June and July productivity in S-H was more than twice as much as that at UM. In July-August it was the other way round, while in August–September productivity was nearly the same in the two stands. This peculiarity can also be observed when taking underground parts into consideration. On the average of the vegetative period productivity was close to the limit value of 18—42 g/m²/day presented in the literature (WESTLAKE 1963). ODUM (1959) and LIETH (1962) gave lower values than WESTLAKE (1963). ODUM gave 2.3 g/m²/day as world average of the growth period, and 4.4 g/m²/day as maximum. LIETH suggested higher values, a productivity of about 5.8—10.8 g/m²/day.

Table 6

Relative growth rate of aboveground parts in maize

Period between dates of sample taking	Újszentmargita	Stuttgart-Hohenheim	Central Minnesota
May—June	0.0919	0.1367	—
June—July	0.0854	0.1038	0.1452
July—August	0.0445	0.0168	0.0310
August—September	0.0119	0.0123	0.0170

Table 7

Cumulative percentage values of aboveground parts in maize

Time of sample taking	Újszentmargita	Stuttgart-Hohenheim	Central Minnesota
May	0.0	0.0	—
June	0.9	1.7	0.1
July	9.4	20.4	11.7
August	43.5	49.6	47.8
September	99.7	99.9	99.8

Relative growth rate (RGR) was calculated only for the aboveground parts (Table 6). Between May and July maize sown in S-H showed a somewhat higher growth rate than that sown at UM. In July–August, however, maize sown in S-H fell to about one-tenth of the value of the previous months, while that sown at UM hardly to the half. In August–September RGR in the two stands was nearly the same. Fall of the S-H stand in July–August can hardly be explained with the meteorological conditions (see MEDINA—LIETH 1964).

Examination of the cumulative values of aboveground parts shows that by August all the three stands suddenly attain 45—50 percent of the total dry weight, then during the next month redouble their weights (Table 7). This great increase of weight during the last month is due to the increased weight of the cobs.

Efficiency calculations of UM data were made as follows: we applied multipliers of 4.0 Kcal/g in May–June–July, 4.3 Kcal/g in July–August, 4.5 Kcal/g in August–September and 3.8 Kcal/g in the case of roots. Average cal. values of aboveground maize parts originating from Újszentmargita:

collected on the 20th June	4.02 Kcal	
„ „ „ 16th July	4.30	„
„ „ „ 21st August	3.99	„ (foliage)
„ „ „ 26th September	3.75	„ (foliage)

Table 8

Efficiency of maize at Újszentmargita (%)

Period between dates of sample taking	Aboveground parts	Aboveground parts and roots
May—June	0.13	0.16
June—July	1.11	1.41
July—August	3.83	3.97
August—September	3.92	3.95
Mean	2.25	2.37

Data of global radiation measured on the field were obtained from Prof. D. Berényi. Results are given in Table 8. The efficiency percentage increases in June–July to nearly ten times its value of May–June; in July–August it is only three times as much as the previous value and remains on this level during August–September. From the S-H experiment, on the basis of the global radiation Lieth (1968) determined an efficiency of 1.2—1.3 percent for the growth season. According to Ovington—Lawrence (1967) in C-M maize and weed together attained an efficiency of 2.1 percent. Blackman (1968) generally mentions 2.9 percent efficiency for maize. On the average the UM data are close to the values presented though in the individual periods there are considerable deviations from the averages.

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*

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THE EFFECT OF CYTOSTATIC D-MANNITOL DERIVATIVES ON GERMINATION AND INITIAL DEVELOPMENT IN BROAD-BEAN (VICIA FABA)

Interest is increasingly focussed on the biological effect of compounds with similar structures. It is known that one of the cytostatic compounds: colchicin is utilized not only in therapy but also in plant breeding, because of its polyploidizing effect.

Hungarian researchers (PÉTERFI *et al.* 1959, 1965) performed a pioneer work in studying the phytobiological effectivity of cytostatic compounds with different structures (e.g. Merapid, Degranol). According to the investigations the cytostatic compounds primarily cause growth inhibitions in the shoots and roots of plants. This inhibiting effect can be characterized with decreased respiration or reduced catalase activity (BALOGH—FRENYÓ 1967). MARÓTI (1967) followed the internal changes by measuring the quantities of protein nitrogen and nucleic acid in callus tissues of tobacco.

The Hungarian pharmacological researchers have attained internationally outstanding results with the sugar alcohol derivatives — first of all with D-mannitol derivatives — out of the most effective cytostatic molecules. These compounds are the following: 1,6-bis (2-chloro-ethyl-amino)-1,6-didesoxy-D-mannitol-dichlorohydrate (Degranol); 1,6-dibromo-1,6-didesoxy-D-mannitol (Myelobromol or in short: dibromomannitol); 1,2,5,6-tetra-methane-sulphony-D-mannitol (Zitostop).

PÁLYI (1967) studied the cytomorphological effects of these cytostatic compounds in HeLa cultures, and found — in addition to a reduced mitosis — considerable polyploid mitosis and the formation of a high amount of multi-nucleated giant cells. HIDVÉGI *et al.* (1967) pointed out — on the basis of measurements made with C^{14} labelled purin base- and amino acid precursors incorporated — considerably decreased DNA-, RNA- and protein synthesis in rabbit marrow treated with dibromomannitol.

LAPIS—BENEDECZKY (1966) supposed general lesions occurring in the membrane system of tumour cells treated with dibromomannitol as a result of changes in permeability and the lysosomatic enzymes released. From studies on action mechanism HORVÁTH—INSTITORIS (1967) drew the conclusion that in addition to its alkalizing effect the dibromomannitol molecule exercised a polarizing effect, too, through adsorption on the lipoprotein membranes, nucleoproteids or enzymes. Thus, by changing the electron system of macromolecules it can cause wrong coupling of bases in the nucleic acid synthesis.

The general biological effect of these compounds necessitates a better knowledge of their phyto-biochemical, cytological, tissue differentiational and physiological characteristics. This paper presents several simple observations. In our investigations the effect of two D-mannitol derivatives (Degranol and Myelobromol) on germination in broad-bean (*Vicia faba* L. cv. "Picardie") was studied, and the growth inhibiting effect of dibromomannitol (Myelobromol) during the initial development of broad-bean followed, with complementary histological studies performed. The investigations were aimed at finding out whether there was any difference in effect between compounds with similar structures, and where and with what intensity this type of compounds acted in the early ontogenesis.

To counterbalance the effects of the cytostatic compounds a number of natural growth regulators [gibberellic acid (GA_3), β-indolyl-acetic acid (IAA)] and synthetic ones (benzimidazole and 6-methyl-uracyl) were also tested.

The germination experiments were carried out with 3 × 100 seeds into glazed earthenware pots filled with pure sand and kept at a temperature of 25° C. 0.1, 0.2 and 0.4 percent tap water solutions were made of Degranol and Myelobromol [both placed at our disposal by the Egyesült Gyógyszer- és Tápszergyár Orvostudományi Főosztálya (Medical Department of

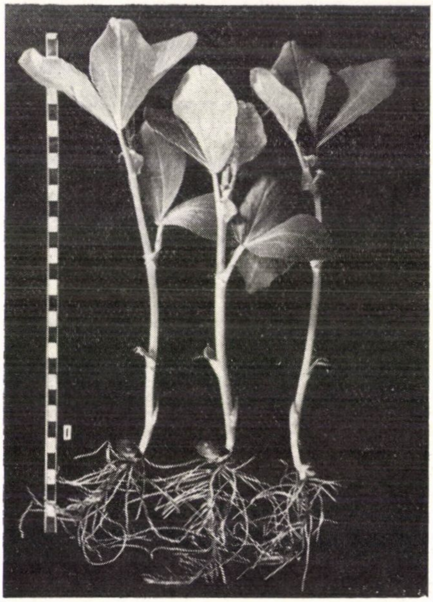
Table 1

Effects of Degranol and Myelobromol (Dibromomannitol) on the germination of broad-bean seeds

	Concentration of solutions %	Duration of soaking and irrigation	Germination percentage on the		
			9th	11th	16th
			day of germination		
Tap water control			64	86	96
Degranol	0.1	permanent	52	86	94
		24 hrs	60	86	94
	0.2	permanent	48	76	88
		6 hrs	64	78	94
	0.4	permanent	40	56	84
		3 hrs	48	80	94
Myelobromol (dibromomannitol)	0.1	permanent	30	48	90
		24 hrs	63	84	95
	0.2	permanent	26	48	84
		6 hrs	50	80	82
	0.4	permanent	30	40	72
		3 hrs	56	80	90

the United Pharmaceutical and Nutriment Works)], and the seeds were treated by soaking the soil with the respective solutions permanently and for definite periods (3, 6 and 24 hours depending on the concentration) respectively.

Cross sections were made of the middle part of the main roots of three days old five cm long seedlings germinated from seeds treated (irrigated) permanently with 0.2 percent dibromomannitol solution, in comparison with control plants raised under similar conditions



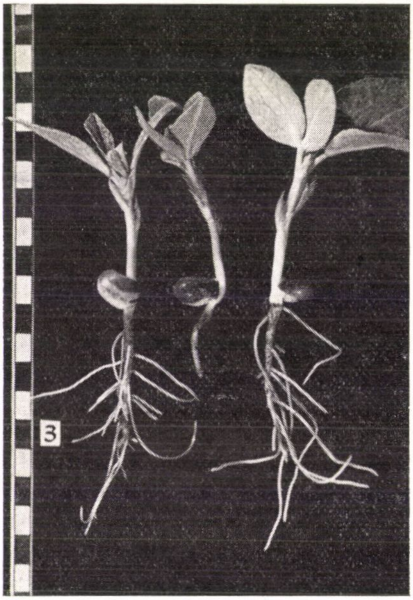
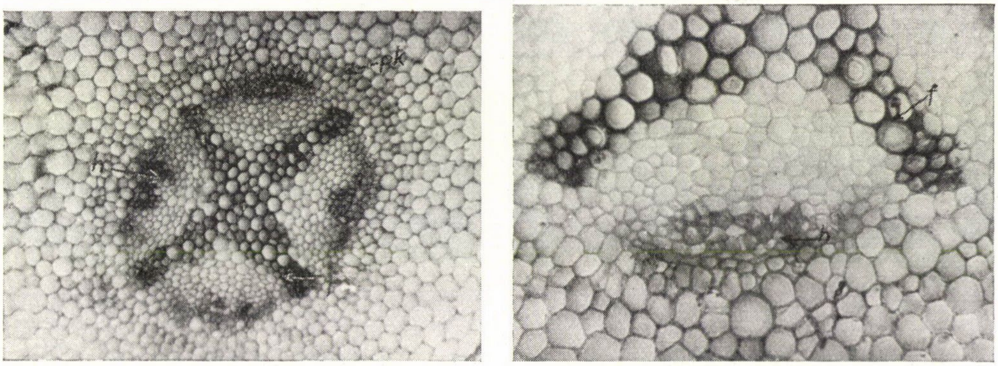


Fig. 1. Effect of Degranol and Myelobromol (dibromomannitol) treatments on the initial development of broad beans. 1. control, 2. 0.2% Degranol, 3. 0.2% dibromomannitol, 4. 0.4% Degranol, 5. 0.4% dibromomannitol



a b

Fig. 2. Effect of dibromomannitol treatment on the meristematic activity of broad-bean roots. Cross section of the main root of a 3 weeks old plant treated with 0.2% dibromomannitol solution. a = central cylinder: 10 × ocular; 4 : 1 proj.; b = part of the central cylinder: 25 × ocular; 4 : 1 proj. (pk = perikambium; h = phloem; f = xylem)

Cross sections were made also of similarly treated 3 week old plants which had stopped growing and had not formed lateral roots.

The germination of the broad-bean seeds is highly reactive to treatments with Degranol and dibromomannitol (Myelobromol) solutions, with a reaction intensity dependent on the duration of soaking and concentration of compounds used (table). The effect of the dibromomannitol is more intensive than that of the Degranol, as the former inhibits germination to a greater extent, especially when used for continuous irrigation (soaking) in concentrations of 0.2 and 0.4 per cent. This can be measured with the rate of germination too, and proved also by the fact that seedlings stop growing, in conformity with the knowledge acquired so far concerning the growth inhibiting effect of cytostatic compounds.

It is interesting that germination is not considerably decreased either by Degranol or by dibromomannitol, while both compounds inhibit the initial development of young seedlings. The sensitivity of seeds is different in spite of the homogenous seed stock and standard conditions, which can be seen from the fact that most germinated seedlings show more or less development, form lateral roots, though their growth is never comparable with the rapid and uniform growth of the control plants. The most effective inhibition can be observed in plants treated with dibromomannitol (Fig. 1). Besides growth inhibition leaf spots as well as withering of shoot- and leaf apex are very often found too.

We tried to counterbalance the manifold and intensive inhibiting effect by applying several regulators affecting tissue differentiation (GA_3, IAA, benzimidazole, 6-methyl-uracyl) in various treatments (spraying, soaking seeds before and after germination) and concentrations (30, 50 and 100 ppm), but in the present experiments the otherwise effective molecules could not relieve or eliminate the cytostatic, general mitosis inhibiting effect of the two D-mannitol derivatives.

According to our investigations mitosis inhibition in the activity of the meristems is manifested — depending on the individual sensitivity — only after the beginning of germination, and with the most effective concentration used results mostly in a complete growth inhibition (inhibition of side root formation, inhibition of secondary growth in the vascular tissue system, destruction of root tips, withering of shoot tips and leaf apices). In this case the activities of the cambium and pericambium are mostly completely inhibited (Fig. 2).

To sum up we can state that there are differences in effectivity between the cytostatic D-mannitol derivatives: the effect of dibromomannitol is more intensive than that of Degranol. The cytostatic effect is of primary character, although it inhibits germination but to a low extent. It seems probable that the primary meristems show different sensitivity in the initial phase of ontogenesis. Root tips of young, several days old plants are the first to show lesions; later they wither, but at the same time intensive inhibition occurs in the activity of the secondary cambia (cambium, pericambium).

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NEATAN-NEW MERCK USED IN EPIDERMAL STUDIES

The epidermis has for some time been studied — beside the methods of clearing leaves and peeling off the epidermis — by imprints of non-toxic mucilage of plants, latex and synthetic films (SAMPSON 1961, SINCLAIR—DUNN 1961, HORANIC—GARDNER 1967).

The 6th Pharmacopoea Hungarica (1967) prescribes the examination of cleared leaves by leaf- and herb-drugs. Instead of clearing the leaves we tried to make imprints by means of Neatan-new Merck generally used in thin-layer chromatography. The leaves were washed with distilled water to remove dust or other contaminations; then the water was wiped off with filter paper and the leaves spread with the milk-like emulsion of Neatan by means of a fine brush. Having dried it left a shining film on the surface. We set to pull off the film after having wetted it with water, a general practice in thin-layer chromatography (RANDERATH 1962). By that time the emulsion must by all means be dry, otherwise it will dilute and spread when wetted. About one minute later the water was wiped up and the film pulled off by means of forceps. Pulling off is best begun over one of the veins, so the leaf is less easily injured. The thickness of the Neatan layer can by regulated by either spreading the emulsion repeatedly over the leaf, or by pouring a little of the emulsion into a watch-glass and spreading it over the leaf after a part of the solvent has evaporated and the emulsion become sufficiently thick.

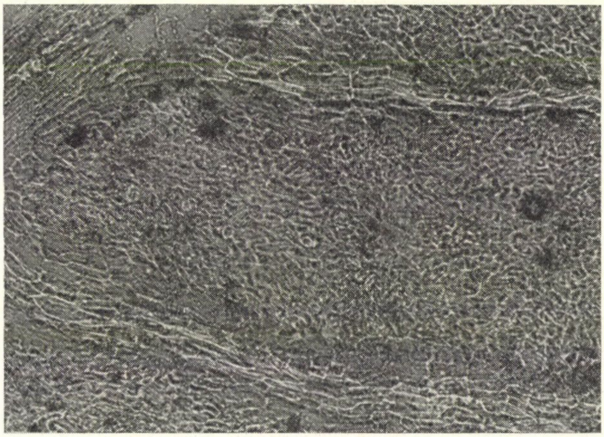

Fig. 1. Part of vein-islet on the bractea of *Tiliae flos.* 63×

The latter is the simpler procedure. Neither too thin nor too thick layers will do. When too thin they will easily get torn when pulled off, when, on the other hand, they are too thick, they are dark and the structure of the epidermis cannot be seen.

The pulled off film was manipulated like the peeled off epidermis and laid on a slide, mounted in water or covered dry and examined under a microscope.

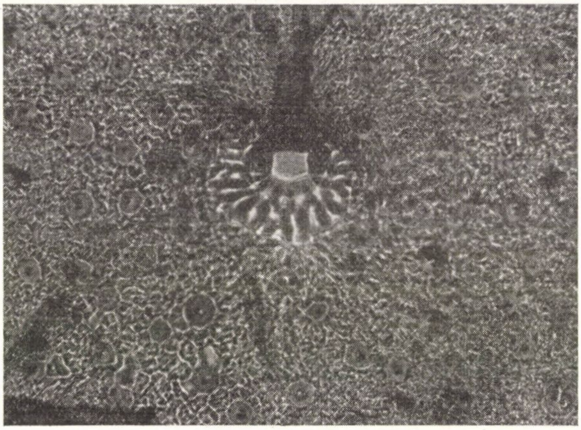

Fig. 2. Part of the epidermis in *Pulmonaria officinalis* L. 63 ×

Fig. 3. Part of the epidermis in *Tradescantia* sp. L. First imprint. 63 ×

In our experience this method can be applied, to leaf-drugs (Fig. 1), herbarium specimens (Fig. 2) and even to living plants (Fig. 3).

With herbarium specimens — as the leaves are smoothed down — Neatan can immediately be spread over the epidermis. With commercial drugs the case is not always as simple as that. For drugs with sufficiently stiff leaves (*Sennae folium*, *Uvae ursi folium*, bracts of linden-trees) we use the same method as with herbarium specimens; less stiff leaves, however, wither while being dried, then roll; later they must be softened in water, smoothed down and wiped. The method cannot be used for densely haired leaves *(Salviae folium)*, because the hairs do not allow the layer to be spread uniformly. With sufficient practice acquired even the epidermis of living plants can be studied with this method. Imprints can be made of the leaves repeatedly (Fig. 4) since Neatan does not cause toxic symptoms to plants.

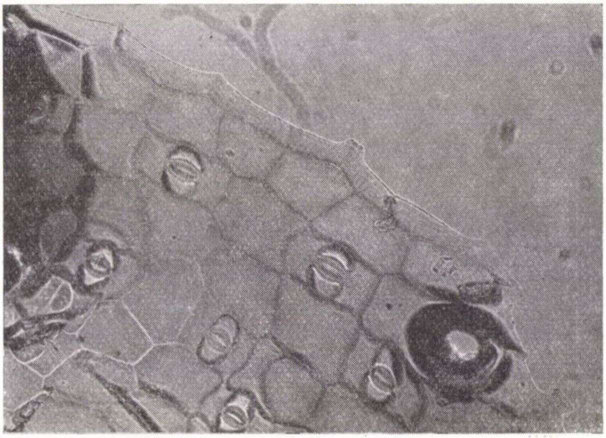

Fig. 4. Part of the epidermis in *Tradescantia* sp. L. Second imprint. 63 ×

To sum up, Neatan-new Merck is a highly suitable aid in studying the epidermis. Imprints are easily prepared with it. It can be used in taxonomic studies (leaves of herbarium specimens can be repeatedly examined), to control drugs and observe leaves of living plants.

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EFFECT OF SUNSHINE HOURS AND TEMPERATURE ON THE DEVELOPMENT OF THE WINTER WHEAT VARIETY BÁNKÚTI 1201

Agricultural production — unlike industrial production — depends to a great extent on external factors man has but a slight influence on. Such are the meteorological factors, which affect the plant throughout its whole life and naturally exercise a considerable influence on the yield as well. Owing to this great influence it is indispensable to express the effect exerted by the meteorological elements on plants in mathematical formulas, since in this case these effects can quantitatively be taken into consideration even if they cannot be influenced.

Such examinations can be performed with the aid of serial data of phenological and meteorological observations carried on parallelly for many years (Wang 1963, Ulanova 1964). These calculations have already been performed for a number of crops in the Soviet Union (Ulanova 1959, Rukovodsztvo . . . 1962).

When the effects of meteorological elements on plants are studied three methods are generally used: a physiological, a statistical and a so called combined method.

It is obvious that the application of techniques of a physiological character in the agroclimatological investigations is limited (e.g. measuring of evapo-transpiration). On the other hand, investigations of pure statistical character — neglecting the biological aspects of plants — may give misleading results. Thus, it seems reasonable to use such a method in the agroclimatological investigations as applying mathematical statistical methods with plant physiological results always in view. In agroclimatology the latter is called the combined method. This method is used in the present paper, too.

The essence of the combined method. This method had earlier been discussed in detail (Varga—Haszonits 1966) and later used to characterize the relationship between the sowing-sprouting period of the winter wheat variety "Bánkúti 1201" and temperature (Varga—Haszonits 1967). Therefore we give here only a brief summary of the method.

The development of plants takes place under the influence of internal inherited characteristics on one hand, and external environmental effects (meteorological, soil- and agrotechnical factors) on the other. The relation of these factors to the life phenomena of plants can be expressed with a mathematical formula:

$$Y - F(\Theta, T) \tag{1}$$

where Y means some of the properties of plants (growth, development, yield amount and quality, etc.), Θ the internal while T the external factors affecting the plants.

Thus, apart from the meteorological factors, the life functions of plants depend on other factors, too. However, agroclimatology requires a correlation expressing plant response to meteorological factors only. External factors are therefore divided into two groups: meteorological (T_m) and non-meteorological (T_n) factors. The latter group includes all external factors affecting the plants except the meteorological ones. Formula (1) may be written accordingly:

$$Y = F(\Theta, T_n, T_m) \tag{2}$$

If we choose a variety and grow it in a definite type of soil with the same cultural practices applied year by year, we can consider the values Θ and T_n as nearly constant. Thus formula (2) expresses the effect of meteorological factors on a chosen plant variety grown under given soil and production conditions. This statement is, however, only approximately true in every case.

It should be mentioned that with the aid of time trends the Θ and T_n values can now be taken into consideration even if they are not regarded as constant (STALLINGS 1962, SHAW 1964, PFAU 1964, OURY 1965).

Plant- and meteorological data. Work with formula (2) requires first of all plant (Y)- and meteorological (T_m) data. Plant data can be: phenometrical, phenological, biochemical and yield data. From the data of plants we choose the one for which we wish to determine the effect of the meteorological factors.

As to the meteorological factors choice is a much more complicated task. It is known from plant physiology that among the meteorological elements temperature and water —and in the case of green plants radiation too — belong to the essential conditions of plants. These elements, however, not only determine the conditions of plant life but also play a dominant role in the whole life process of plants, since photosynthesis requires energy and water while the rate of the chemical reactions is greatly influenced by the temperature. Therefore these factors are called basic (dominant) factors (DAVITAYA 1948, TURC 1958). Factors — on the other hand — that act primarily by influencing the basic (dominant) factors (clouds, wind, etc.) are considered secondary (non-dominant) factors.

Formula (2) is valid only to the extent where the intensity of the meteorological element in question reaches a certain critical level beyond which it becomes harmful or even destructive for the plants. These meteorological elements surpassing the critical level are called harmful factors (frost, storm, etc.). It may happen that several meteorological elements reach the critical level at which they become harmful for plants (drought, etc.) at the same time. When studying these factors we try to find correlations between their intensity and the extent of damages done by them.

It is the basic (dominant) factors that should be first considered in our study. However, these factors can usually be characterized by the value of several meteorological elements. Temperature may be: air temperature, plant temperature or soil temperature. For this reason we speak of elements of direct and indirect action respectively (STALLINGS 1961). An element of direct action is e.g.: plant temperature, one of indirect action is e.g.: air temperature.

It follows from the foregoing that it is advisable to choose the elements of direct action from the dominant factors. Unfortunately, often no data on them are available, so instead of soil- or plant temperatures the closely related air temperature data are normally used.

The meteorological data can also be the measured or calculated values of individual meteorological elements, or else complex values.

The relationship between the development of the winter wheat variety Bánkúti 1201 and the meteorological factors was determined by means of the above described method.

Relationship between winter wheat and meteorological elements. The effect of meteorological elements on winter wheat has been studied by many scientists in Hungary. KERÉK (1934), VÁGSELLYEI (1937), BERÉNYI (1951) and PINTÉR (1955) studied the relationship between meteorological elements and yield amounts. MÁNDY (1960, 1961) found the growth rate of winter wheat to be dependent on certain meteorological elements. SZÁSZ (1961) and SZAKÁLY (1963, 1966) analyzed the effect of climate on the phenological characters. VARGA—HASZONITS (1967) dealt with the mathematical analysis of the relationship between plant development and meteorological elements.

The present paper also sets the aim of preparing a mathematical analysis of the effect of sunshine hours and temperature on the development of plants.

To demonstrate the effect of meteorological factors on plants both plant- and meteorological data are required.

In the Central Institute of Meteorology phenological observation of cultivated plants has been carried on since the early fifties. Thus at some sites more than ten years' phenological observations are at our disposal. In the present study the 11 years' (1952—62) phenological data relative to the winter wheat variety Bánkúti 1201 from six observation sites (Debrecen, Karcag, Bánkút, Kecskemét, Iregszemcse, Hathalom) are used. The phenological analysis of these data was carried out by SZAKÁLY (1963).

Data from meteorological stations nearest to the phenological observation sites were used to characterize the meteorological elements.

Relationship between meteorological factors and plant development. According to SCHNELLE (1955) the development of plants is influenced primarily by the radiation and temperature conditions. On the basis of investigations carried out in a phytotron WENT (1957) arrived at similar conclusions. For this reason we too began our investigations into the relationship between meteorological factors and plant development by using data on sunshine hours and temperature.

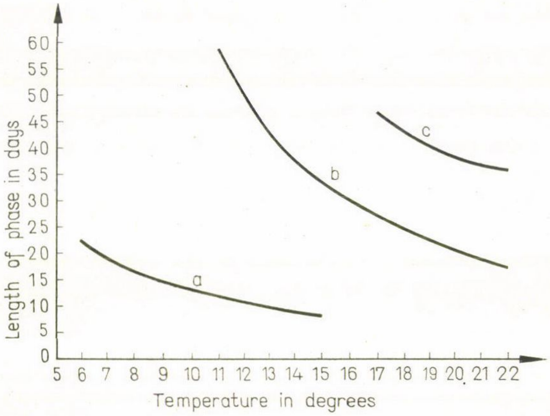

Fig. 1. Effect of temperature on development in winter wheat

Relationships between temperature, sunshine hours and photothermal index on one hand, and lengths of developmental phases in the winter wheat variety Bánkúti 1201 on the other, were determined on the basis of formula (2). The correlation coefficients are presented in Table 1. Values shown by Table 1 are significant even at P = 0.01.

The effect of temperature on plant development can be expressed by the following function:

$$Y = \frac{a}{x^b} \tag{3}$$

Y means the length of the phase in days, x the mean temperature of the phase in centigrades, a and b are constants, changing by developmental phases, so the empirical forms of formula (3) will differ from one another in the individual phases of development (Fig. 1 a, b, c curves).

The relationship shows that if temperature rises the length of phase will be shorter and vice versa: if temperature falls the length of phase increases. The phasic length change per 1 centigrade temperature rise or fall can be easily determined from the empirical function (Fig. 1). It shows further that 1 centigrade temperature changes occurring at different temperatures induce various phasic length changes. Thus the winter wheat variety Bánkúti 1201 reacts to temperature changes occurring at different temperatures with different rates of development.

The effect of sunshine hours on plant development can be expressed with a straight line. When the number of sunshine hours increases, the length of phase increases too, and when the former decreases the latter decreases as well. The empirical constants of the straight line are different in each phase in this case too.

The correlation coefficient obtained for the phase between sowing and sprouting was put in brackets, as in that period the plant is in the soil, so sunshine has no direct effect on it.

Thus both temperature and sunshine hours have considerable effects on the development of the winter wheat variety Bánkúti 1201. Since, however, the two meteorological elements are in close correlation with one another as well, it is very important to examine their combined effect on the development of the winter wheat.

Table 1

Effect of thermal factors on the length of the developmental phase

	Sowing-sprouting	Shooting-earing	Earing-waxy ripening
Temperature	−0.62	−0.77	−0.70
Sunshine hours	(0.46)	0.88	0.67
Photothermal index ..	−0.94	−0.91	−0.84

Meteorological elements summed up in time may give misleading results, as the usually higher value of the element totalled for more days (longer phase), or usually lower value totalled for fewer days (shorter phase) may show a close connection with the length of phase without any reasonable correlation. Sunshine duration (and heat sum too) is a similar meteorological element. Therefore it seemed reasonable to express the complex effect of the two elements with a value that determines temperature changes per unit sunshine

$$i_0 = \frac{t}{h} \cdot 1000 \tag{4}$$

where i_0 is the photothermal index, t the mean temperature of the developmental phase expressed in centigrades, and h the total amount of sunshine hours in the developmental phase. With the aid of the multiplier 1000 the values of the photothermal index are given in whole numbers.

As it is seen from Table 1 the photothermal index shows the closest correlation with plant development. Table 1 shows further, that winter wheat is the most sensitive to changes in thermal meteorological elements in the phase of shooting and earing. Sensitivity to thermal factors — though decreasing — is still considerable in the phase of earing and waxy ripening.

Relationship between photothermal index and plant development can also be determined by the formula (3). In this case, however, x means the value of the photothermal index. Empirical constants for the individual phases of development are the following:

	a	b
sowing — sprouting	963	0.82
shooting — earing	715	0.75
earing — waxy ripening	531	0.64

If the value of photothermal index and phasic length in the three examined phases of development are represented — as in the case of temperature — by a single figure, the groups of points join, that is, the correlation for the three phases can be expressed by a single function (Fig. 2). The analytical form of the function can also be given with formula (3). Its empirical constants are: $a = 916$, $b = 0.80$; the value of the correlation is 0.95. (The increased closeness of the correlation can be explained by the fact that the common mean value of phasic length — with one or two exceptions — is higher than the values of sowing — sprouting phasic lengths, and lower than those of the spring phasic lengths. With the photothermal index it is the other way round: its autumn values are generally higher and spring values lower than the overall mean value.) It follows that changes in the phasic lengths of winter wheat are caused to some 90% by the joint effect of sunshine and temperature.

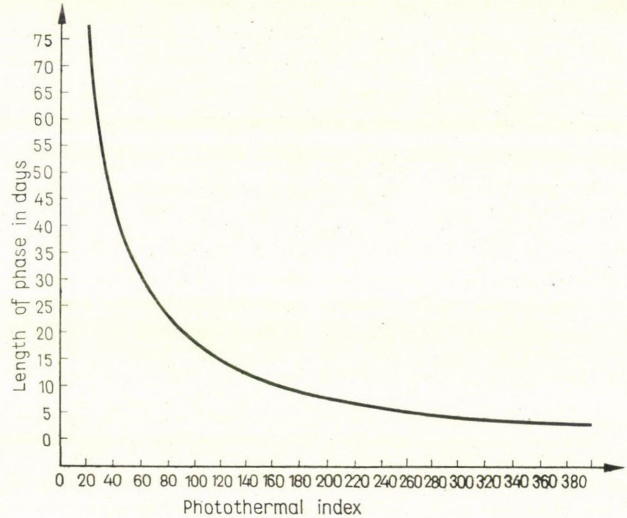

Fig. 2. Joint effect of temperature and sunshine hours (photothermal index) on the development of winter wheat

Thus, if a low number of sunshine hours is combined with high temperatures the development of winter wheat slows down, while in the case of much sunshine combined with low temperatures the development accelerates. The phasic length change belonging to the 1000 degree/hour photothermal index value can be read from the function in Fig. 2.

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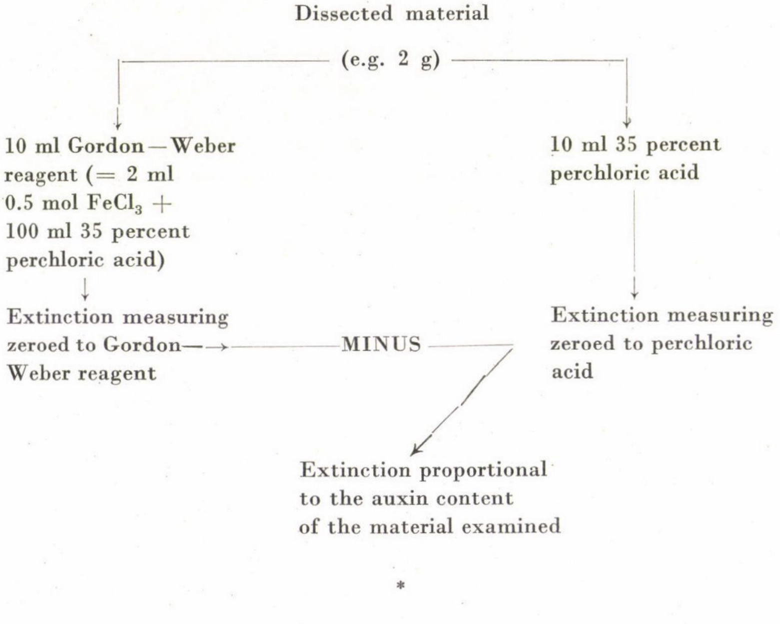
A NEW METHOD FOR THE RAPID DETERMINATION OF AUXIN CONTENTS

The test has the following steps:

1. An adequate amount (e.g. 1—2 g) of plant material dissected into fractions of 2—3 mm is extracted with 10 ml 35 percent perchloric acid, and the same amount with 10 ml Gordon—Weber reagent, for 1 hour, while stirred from time to time.
2. Both solutions are filtered then poured into cuvettes (of 5 ml) for the purpose of photometry. The perchloric acid solution is controlled for zeroing with 35 percent perchloric acid, while the Gordon—Weber solution with Gordon—Weber reagent.
3. Extinction is measured with the Uvifot apparatus at the wavelength of IA (510 nm).
4. Separately determined extinction values of the Gordon—Weber- and perchloric acid solutions are subtracted from each other, and the difference shows the extinction produced by the Gordon—Weber reagent under the influence of the given auxin content. Subtraction of the extinction of the perchloric acid solution from that of the Gordon—Weber solution ensures that the extinction of natural colour substances extracted together with the auxin will be eliminated and the test thus made precise.

The above method is suitable not only for the determination of the relative auxin content, but with a calibration curve drawn from the extinction of a concentration serie of beta-indolyl-acetic acid measured at IA wavelength the free auxin content can also be concluded on.

The pattern of the test



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T. **Brunner**, Zs. **Antoni**

FLOWER AND FRUIT NAMES IN HUNGARIAN FOLK-SONGS

It is from RAPAICS' summarizing works (1932, 1940) that we can gather detailed information about the favourite flowers and fruits of the Hungarian people.

The well known old Hungarian folk-songs and folk-tales often contain names of plants. The frequency of these plant names has an interesting relation to the most popular flowers and fruits of the Hungarian people. The present paper is confined to a brief analysis of some 500 Hungarian folk-songs selected by KODÁLY—VARGYAS (1969) (mostly folk-songs collected in Transylvania, Upper Northern Hungary and within the boundaries of the country since the beginning of the century).

The most popular flowers of the Hungarian people are the rose, the lily, the gilly-flower, the daisy, the valley lily, the carnation, the rosemary, the tulip and the geranium; they all have their part in Hungarian folk-songs. It is known that among these flowers the favourite ones have names of Latin origin; the words: "rózsa" (rose), "liliom" (lily) and "viola" (gilly-flower) were introduced into the Hungarian language with the spread of Christianity, although their history reaches back to the times of ancient cultures.

The favourite flowers and flowering fruit-trees that later the people got to know, too and the names of which were adopted were first introduced in the gardens of cloisters and feudal castles in the Middle Ages; e.g. "rózsa" (rose), "bazsarózsa" (peony), "csipkerózsa" (hedge rose), "ibolya" (violet), "viola" (gillyflower), "liliom" (lily), "szegfű" (carnation), "rozmaring" (rosemary), "búzavirág" (cornflower), "alma" (apple), "körte" (pear), "cseresznye" (cherry), "meggy" (sour cherry), "mandulafa" (almond tree), etc. The forget-me-not adopted from the flower tales as well as the most frequently used garland plants: the marjoram and the rosemary are especially loved by the people. The occurrence of their names in folk-songs was already mentioned by RAPAICS (1932).

The tulip was brought into Europe by the Turks; the popular chest painted with tulips is well known not only in Hungary but all over Europe.

As to the names of fruits, according to RAPAICS (1940) the word "meggy" (sour cherry) is of Finno—Ugrian origin, and the fruit itself was already known by the proto-Hungarians in the Volga district where the dwarf morello is a native plant. However, most fruit names, e.g. "alma" (apple), "körte" (pear), "kökény" (blackthorn), "szőlő" (grape), "mogyoró" (hazel-nut), "som" (cornel), etc. are of Bulgarian—Turkish origin (BENKŐ 1967). The Hungarians got acquainted with these plants when meeting the Bulgarian-Turkish tribes. Another result of the southern influence is the knowledge of oak, acorn and nut adopted from the Iranian Alan people, and the use of their names ("tölgy", "makk", "dió").

Each of the plant names listed so far occurs in the Hungarian folk-songs. As a guidance we subsequently list the names of plants encountered during the analysis of 495 folk-songs (KODÁLY—VARGYAS 1969). Beside each name in brackets the Latin name of the species or genus and occasionally the related compound words are presented. The list was compiled according to the frequency of occurrence, and the number of occurrence is also given in brackets

The most frequently used plant names are the following:

rózsa (rose) (*Rosa* sp. — rózsabokor (rose bush), rózsafa (rose tree), tearózsa (tea-rose); 25)

búza (wheat) (*Triticum aestivum* — búza kenyér (wheaten bread), búza szem (wheat grain), búzaszál (wheat-stalk), búzapiroslás (the red colour of wheat), búzavirág (cornflower); 14)

alma (apple) (*Malus* sp. — almafa (apple tree); 9)

rozmaring (rosemary) (*Rosmarinus officinalis* — rozmaringszál (rosemary stalk), rozmaring szálacska (little rosemary stalk); 11)

szőlő (grape vine) (*Vitis vinifera* — szőlővirág (grape flower), gerezd szőlő (a bunch of grapes);6)

kukorica (maize) (*Zea mays* — kukorica derce (maize groots), kukoricaszál (maize stalk), édesmálé (sweet corn-cake); 6)

nyárfa (poplar) (*Populus* sp.; 5)
szegfű (carnation (*Dianthus caryophyllus* — szegfűvirág (carnation flower); 5)
szilva (plum) (*Prunus domestica* — szilvafa (plum tree); 5)
csipkebokor (briar) (*Rosa canina* — csipkebokorrózsa (briar rose); 4)
dió (walnut) (*Juglans regia* — diófa (walnut tree); 4)
kender (hemp) (*Cannabis sativa* — virágos kender (flowering hemp), kenderke (little hemp); 4)
zab (oats) (*Avena sativa*; 4)

The following plants occur three times:

cédrusfa (cedar tree) (*Cedrus* sp.)
cseresznye (cherry) (*Cerasus avium* — cseresznyefa (cherry tree), cseresznyefalóca (cherry wood bench)
cserfa (Turkey oak) (*Quercus cerris* — cserfahéj (tanbark), cserfa füst (oak-wood smoke) cserfakéreg bocskor (tan-bark moccasin)
fügefa (fig tree) (*Ficus carica* — fügefalevél (fig leaf))
fűzfa (willow) (*Salix* sp. — szomorúfűzfa (weeping willow))
káposzta (cabbage) (*Brassica* sp.)
liliom (lily) (*Lilium candidum* — liliomszál (lily stalk))
majoránna (marjoram) (*Majorana hortensis)*
viola (gilly-flower) (*Matthiola incana* — violaszál (a stalk of valley lily))

The following plants occur once or twice:

árpa (barley — *Hordeum* sp.); bab (bean — *Phaseolus vulgaris*); bodorka (*Trifolium* sp., probably *T. retusum*); bors (black pepper — *Piper nigrum*); bükkfa (beech-tree — *Fagus silvatica*); citromfa (lemon tree — *Citrus limon*); dinnye (melon — *Citrullus* sp. or *Cucumis melo*); gomba (mushroom); gyöngyvirág (lily of the valley) (*Convallaria majalis)*; hajdina (buckwheat — *Fagopyrum esculentum*); ibolya (violet — *Viola odorata*); jegenye (poplar — *Populus nigra* ssp. *pyramidalis*); komló (hop — *Humulus lupulus*); kökény (sloe — *Prunus spinosa)*; körtefa (pear-tree — *Pyrus* sp.); krumpli (potato — *Solanum tuberosum*); lencse (lentil — *Lens culinaris*); lucfa (Norway spruce — *Picea abies*, perhaps *Pinus* sp.); makk (acorn— *Quercus* sp.); málna (raspberry — *Rubus idaeus*); meggyfa (sour cherry-tree — *Cerasus vulgaris*); mogyoró (hazel nut — *Corylus avellana*); murok (carrot — *Daucus carota*); nád (reed — *Phragmites communis*); nefelejcs (forget-me-not — *Myosotis* sp.); nyírfa (birch-tree — *Betula* sp.); petrezselyem (parsley — *Petroselinum crispum*); pünkösdi rózsa (peony — *Paeonia officinalis*); retek (radish — *Raphanus sativus*); rezeda (mignonette — *Reseda odorata*); ruta (rue — *Ruta graveolens*); saláta (lettuce — *Lactuca sativa*); tulipán (tulip — *Tulipa* sp.); uborka (cucumber — *Cucumis sativus*); vöröshagyma (onion — *Allium cepa*).

In 25% of the selected 495 folk-songs, that is in 125 folk-songs there are a total of 47 plant names. As a matter of curiosity it can be mentioned that Sándor Petőfi used 34 popular plant names in all his poems (Rapaics 1932).

The data and the rates are, of course, only of informative character, but it is probable that they are similar in the whole stock of Hungarian folk-songs.

Beside the popular flower- and fruit names in many cases names of a number of horticultural- and spice plants are also found in comical folk-songs, e.g.: cabbage, lentil, bean, melon, carrot, parsley, radish, lettuce, cucumber, onion, etc. They mostly occur in melodious comparisons.

The word wheat and its derivatives, as well as the names of other cereals: barley, oats, are strikingly frequent; even the names of maize, hemp, hop and potato occur. It is interesting that the popular name of the valuable salt tolerant wild clover variety of the Hungarian steppe (*Trifolium* sp., probably *T. retusum*) has also its part in one of the folk-songs of Békés County (Herman 1914).

To sum up, it can be stated that the old plant names of the Hungarian people, especially the favourite flower- and fruit names abundantly occur in the Hungarian folk-songs making them colourful and variegated.

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NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY APPLIED IN AGRICULTURAL RESEARCH

In our days science is characterized by the overlapping of scientific branches. It often occurs that a joint effort of two or more branches of science is required for solving a more complex problem and it has become an everyday practice that results obtained in one field of science are utilized as new means of research by another field. This is also the case with scientific fields apparently rather distant from each other, as e.g. nuclear physics and agricultural research, breeding.

The question whether a scientific result is thoroughly known or not is decided by the extent it is utilized in practice. Description of the behaviour of nuclei in a magnetic field belongs strictly to the sphere of physics. It was physical research that explored the details of this phenomenon, and pointed out the fact that under identical conditions the nucleus shows a characteristic behaviour and this behaviour depends exclusively on its properties, its direct, very close environment (crystal type, configuration, chemical bond, and the structure of the nucleus itself, etc.). Accumulation of a sufficient amount of information has made it possible to draw conclusions from the behaviour of the nucleus in known circumstances on its quality, status, environment, etc. This fact implies, however, the possibility of utilizing the phenomenon as a means of research in solving problems of not mere physical character. Agricultural research and breeding may be such users.

The present paper is aimed at analysing the applicability of nuclear magnetic resonance in agricultural research, first of all on the basis of literary data available, without any claim to completeness, taking into consideration that in agricultural research the main emphasis is laid on methods making examinations of high serial number possible in a relatively short time.

In agricultural research this method has the great advantage of providing an opportunity to carry out measurements on living material (e.g. seeds) without its being injured and lost for breeding. We have not been able so far to perform such examinations with the traditional physical, chemical and biochemical methods.

Nuclear magnetic resonance. The phenomenon of nuclear magnetic resonance (subsequently: NMR) was discovered in 1946 by E. M. Purcell *et al.*, and separately by P.Bloch *et al.* The development of the phenomenon of NMR, methods of detection, the relationship between its shape and measurable parameters and the nucleus and its environment, chemical shift, etc. are not dealt with here in detail. They are discussed in detail by Feynman *et al.* (1970), Fluck (1963), Hopkins (1965), Lösche (1957), Kittel (1966), Pople *et al.* (1959). We should only like to give a general physical picture of the bases of the phenomenon here.

If nuclei are placed in a constant external magnetic field (H_0), then the number of positions the magnetic momentums of nuclei (μ) can occupy in relation to the H_0 magnetic field will be $2S + 1$, where S means the spin of the nuclei. The nuclei display a precessive movement in accordance with the direction of the H_0 magnetic field.

The frequency of precession ν_0 is:

$$\nu_0 = \frac{\mu}{Sh} H_0 \qquad\qquad \gamma = \frac{\mu}{Sh}$$

where h is the Planck constant and γ the gyromagnetic constant of the nucleus. If the constant H_0 magnetic field is superposed by a magnetic field of H_{ν_0} frequency, the direction of which forms a right angle to that of H_0, the magnetic momentums of nuclei change their direction (the angle of precession changes) and detract the energy required for this from the H magnetic field. The magnitude of frequency falls within the range of radio frequency.

In practice resonance does not occur at a single ν_0 frequency but in a $\Delta\nu_0$ range of the ν_0 frequency. The reason is that atomic nuclei are influenced — in addition to the constant external H_0 magnetic field — by the magnetic fields of adjacent atoms which are different. So the magnetic field that affects the nuclei is not uniform, and resonance, accordingly, does not occur at a single ν_0 frequency, but in the frequency band of $\Delta\nu_0$. On this basis it is understandable that from the width of NMR we can conclude on interactions between the nucleus and its environment, and the mark is expected to widen in substances where the adjacent nuclei intensively affect each other (e.g. in metals and crystalline compounds), and to become much narrower in substances where the effects of adjacent nuclei are low or negligible (e.g. in solutions of crystalline compounds).

One of the methods of demonstrating energy absorption occurring at the resonance frequency was developed by E. M. Purcell. The basis of this method is that samples to be examined are placed in the reel in the homogeneous external magnetic field, which is, at the same time the induction part of the oscillating circuit of an oscillator. Magnetic momentums swinging over the resonance frequency detract the energy required for the swing-over from the electro-magnetic field of the reel as demonstrated by radio-technical means. The other method was elaborated by P. Bloch. Here too, the sample is in the homogeneous external magnetic field, the precessing momentums are forced to swing over by the electro-magnetic field of which the frequency is identical with that of the precession. The electromagnetic radiation emitted during the transition induces a radio-frequency potential in the reel placed beside the sample which can also be demonstrated by radiotechnical methods.

In agricultural research the NMR-method can be efficiently used in the following fields:

When applied together with a destruction procedure:

1. Demonstration of elements and inorganic compounds on the basis of separate NMR marks of ^{1}H, ^{11}B, ^{14}N, ^{19}F, ^{31}P, ^{63}Cu, etc.
2. Examination of the composition of organic compounds:
   a) Fatty acids, glycerids.
   b) Peptids, amino acids.
   c) Carotinoids, plant protectives, etc.

When applied destruction-free (in intact plant parts and seeds)

1. Water content determination.
2. Oil content determination.
3. Determination of nitrogen compounds.

Of the examples listed above determination of peptids, amino acids, water content and oil content will be dealt with in detail. The majority of the NMR methods combined with desctruction belongs to the so called high resolution NMR spectroscopy, while measurements made with intact samples fall within the sphere of broad-line NMR spectroscopy. The determinations of elements disclosed by destruction can be included here too.

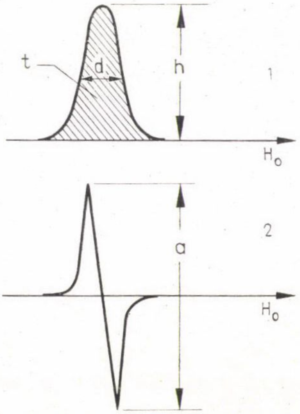

Fig. 1. The NMR-mark (1) and derivate (2) of proton. Parameters measurable: h = height, d = width, t = area, a = peak-to-peak amplitude

The measurable parameters of NMR are the following: field below the mark (*t*), height of its peak (*h*), half-value width of the mark (*d*), peak-to-peak amplitude of the derived mark (*a*) — as seen in Fig. 1. The field below the mark is proportional with the number of protons taking part in the resonance. This means that if e.g. the NMR spectrum of a fatty acid is concerned, in which hydrogen nuclei are in three different chemical environments, and so three separate resonance peaks are obtained, the proportion of the fields below the peaks corresponds to the numerical proportion of hydrogen nuclei in the individual chemical environments.

Study of elements. The NMR spectroscopy of certain elements — and generally of inorganic compounds — is dealt with by **Fluck** (1963) in great detail; he gives particulars about certain important macro- and micro-elements occurring in plants (^{1}H, ^{14}N, ^{31}P, ^{13}C, ^{17}O, ^{27}Al, ^{11}B, ^{29}Si, ^{115}Sn, ^{119}Sn, ^{207}Pb, etc.) The above work gives no formula for the identification of these elements, it only refers to the relevant literature. Even these literary data are no more than a footing, and a lot of methodological problems should be solved if these elements are to be identified in the living amples of plants.

Study on fatty acids and their components. It was around 1958 that the NMR method was first applied in studying fatty acids and their components (**Hopkins—Bernstein** 1959, **Pople** *et al.* 1959, **Rinehart** *et al.* 1958). It was applied to fatty acid components by **Hopkins** (1965). The studies are based primarily on the NMR spectroscopy of protons. The NMR frequency of the proton (hydrogen nucleus) depends on its chemical surroundings. The resonance frequency of a hydrogen nucleus which can be considered isolated is called reference frequency. Such is e.g. the atomic nucleus of the hydrogen contained in chloroform. The development and measurement of resonance frequencies deviating from this as well as their dependence on the chemical environment are described at length in the literature, with ample literary references (Fluk 1963, Hopkins 1965, Pople *et al.* 1959, Kenning 1961).

Analysis of mixtures. The NMR spectroscopy method can also be used in the case of mixtures of partially hydrogenized acids. Storey (1960) studied the analysis of mixtures originating from the partial hydrogenization of linoleic acid. High resolution NMR spectra of methylesthers of stearin, oil, linol and linoleic acid formed the basis of the study. The methylesther band served for reference, comparison was carried out by the measurement of the area bellow the marks. The mixture of methylesthers originating from the linoleic acid hydrogenized gave six significant bands, function groups were presented in a table. It can be expected, that the solution of the simultaneous equations based on the integration of the areas below the bands gives the construction of the 8-component mixture. The author pointed out that an analysis like that is only possible when one of the components has already been determined with some other method. The measured values of the areas related to the area of the reference esther-band did not quite agree with the actual proton proportion, and it seems that experiments still have to be continued. The method can be successfully used with mixtures of several components as proved by subsequent researches.

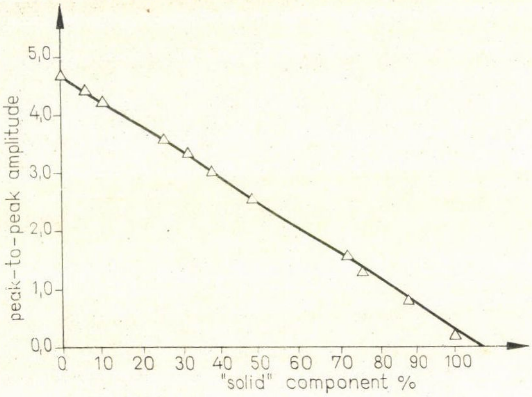

Fig. 2. Peak-to-peak amplitude of NMR-derived mark of liquid non-hydrogenated soyaoil as plotted against the "solid" component of soyaoil

The method of broad-line NMR spectroscopy is suitable for determining the proportions of the liquid-"solid" components of soyaoil and margarine of varying hydrogenation degree (Hopkins 1961, Pople *et al.* 1959). Proportions obtained with NMR spectroscopy reproducibly agree with the absolute liquid-"solid" ratio, and agree with the dilatometrically measured data. Duration of measuring can be reduced with the method, and this makes it possible to control the hydrogenation degree of soyaoil automatically in a circulation- or tub-system. Although no exact theoretical correlation exists between empiric dilatometry and direct proton mobility measurable with the NMR method, a close correlation can still be found between the data of the two methods if the temperature dependence of NMR is taken into consideration. The method is quick, not destructive and the shortest possible time is required for the samples to be prepared. The relationship between the "solid" component of soyaoil and the value of NMR is shown by Fig. 2.

Study of peptids and amino acids. Sievers *et al.* (1969) reported on a very interesting and important method suitable for analysing peptid and amino acid mixtures. This method is based on the NMR spectrum of the ^{19}F atomic nucleus measured in the form of trifluorineacetyl (TFA) or other fluorine containing peptid and amino acid derivatives. It has already been published that the NMR of fluorine is suitable for quantitatively analyzing metals such as the tri-fluorine-acetyl-acetone(TFAA)-chelate derivatives. Although the proton resonance spectra of Zr(IV) TFAA, and Hf(IV) TFAA are essentially similar in chloroform, fluorine peaks are easily separated (0.23 ppm) and used in the quantitative analysis of Zr and Hf. It is a well known fact that the chemical shifting of fluorine is somewhat more sensitive to sligh changes in toning than that of the proton. Experiences gained with the fluorine NMR of similar extreme metal-chelates led the authors to the idea that this method may be likewise suitable for detecting slight differences in the chemically and structurally highly similar peptids and amino acids. They took down the NMR spectra of N-TFA derivatives of amino acids and peptids prepared accordingly, as seen in Fig. 3. They show that nuclei containing fluorine reflect the slight differences in structure in the resonance peaks of those TFA groups which are in the characteristic position. It must be noted that the chemical shifting of N-TFA reflects the differences of not only those amino acids to which the N-TFA group is directly attached, but is influenced by the other amino acid too.

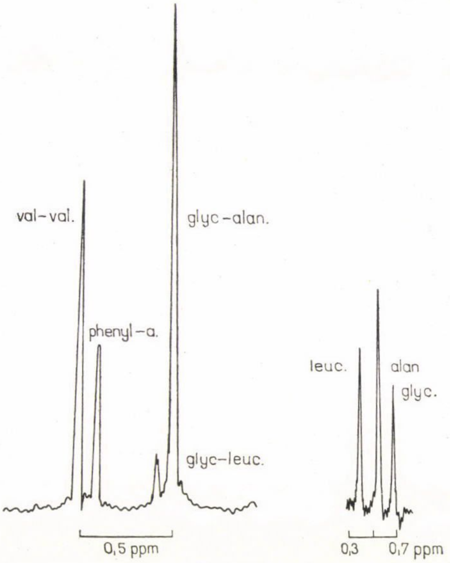

Fig. 3. NMR spectrum of the 19-F atomic nucleus of valine-L-valine, L-phenyl-alaine, glycine-L-leucine and glycine-L-alanine N-TFA-derivative. Upper figure: NMR spectrum of the 19-F atomic nucleus of 11 mg L-leucine, 14 mg L-alanine and 6 mg glycine N-TFA-derivative

Compared to the techniques of gas chromatographic and mass spectrometric amino acid analysis the method has a great advantage, namely that the components need not be in a volatile form, so long peptids can also be analyzed with this technique. Further results showed that estherification is unnecessary. The chemical shift of N-TFA glycine is independent of the concentration in a range between 2 and 30 weight percentage, in acetone solvent. A great advantage of the technique is that it is much quicker than the earlier techniques. The spectrum is taken in minutes, while the Stein-Moore liquid chromatographic method requires hours for the separation and analysis, and even the much quicker gas chromatographic technique requires about one hour for the analysis after the derivative has been produced. N-TFA derivatives can be easily produced and there is a possibility of automatizing the whole process of analysis.

Causes of changes occurring in the NMR spectrum of polypeptids were studied by **Bradbury** *et al.* (1968). They studied the structural transformation of the spiral coil. **Crespi** *et al.* (1968) examined the proton NMR of totally deuterized proteins with the exception of the ^{1}H-lucine side-chain. The structure of a pyrimidine amino acid of pea was studied with various methods including the NMR technique by **Brown—Mangat** (1969). They found that the amino acid was β-(a,6-dihydroxypyrimidine-1-il) alanine, and — notwithstanding earlier findings — occurred in a free state.

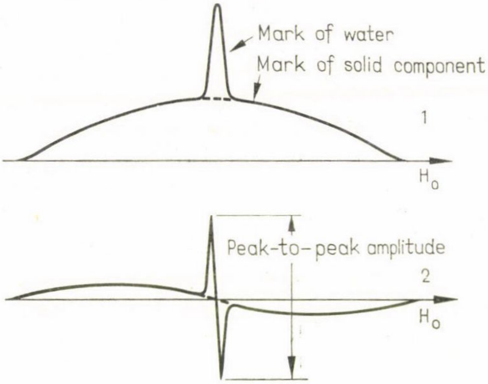

Fig. 4. Absorbed water in biological substances. Mark of absorption NMR (1) and its derivate (2)

Carotinoids and plant protectives. **Hopkins** (1965) mentions the NMR spectroscopy of carotinoids. The necessary amount of material is 1—10 mg.

The technique was first applied systematically for carotinoids by **Barber** *et al.* (1960) who examined the methyl groups of 64 carotinoids. Chlorophyll was studied by **Katz** *et al.* (1966) with infra-red and NMR methods. The organic phosphorus content of plant protectives was examined by **Keith** *et al.* (1968) with high resolution NMR spectroscopy. NMR spectra of 100 MHz were determined for 40 compounds. They found a correlation between molecular structure and spectra. **Callis** *et al.* (1956) dealt with phosphorus—oxyacid identifications and determined the chemical shift of various phosphate anions.

Water content determination. The NMR technique which had been primarily evolved for the purpose of chemical analyses involved water content determinations in the case of many substances and products. In agriculture and fat production, etc. the conventional method of water content determination is often time-consuming and unsatisfactory for other reasons too. The NMR method applied to water content determination was gradually developed by **Shaw** (1950) and others. The method is based on the fact that in certain substances the water molecules are relatively more mobile compared to those containing a lot of hydrogen bonds, as e.g. crystals, amorphous solids or solutions of high viscosity. Therefore the proton resonance of such systems looks like a large broad mark superposed by a narrow one originating from absorbed water. This is shown schematically by Fig. 4. This figure resembles the form in which the proton NMR appears in the analysis of oil content. The upper curve shows the absorption curve. In most cases the line of the absorbed water is two or three times as wide as that of clear water. Since the lines of the other substances are ten- to hundred times wider, the intensity of the mark of water can be used in the quantitative measurements of water contents. In practice it is very comfortable to use the derived curve and measure its peak-to-peak amplitude. Such a typical curve is shown by Fig. 4/2. The NMR technique is quick, not destructive, and can be automatically controlled by the results, in the form of electric signs, e.g. drying and mixing. The method is not forced, it is of elementary dimension, and can be applied to a wide range of substances with water contents varying from a few to 100 per cent.

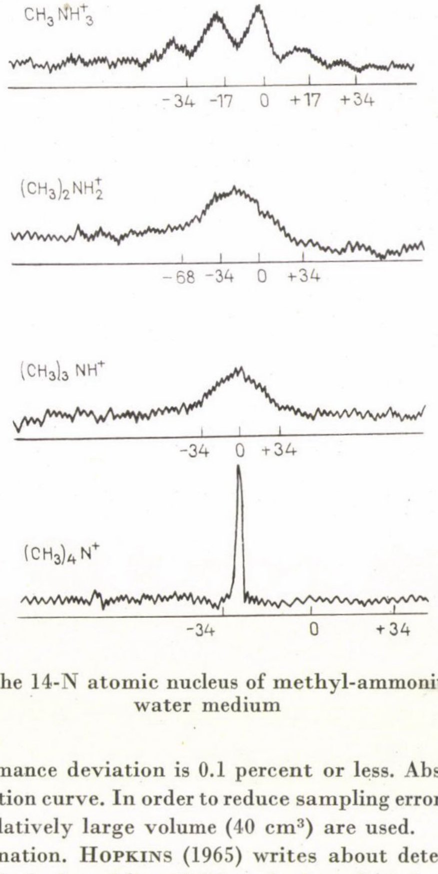

Fig. 5. NMR spectrum of the 14-N atomic nucleus of methyl-ammonium-chloride in an acidic water medium

In case of a precise performance deviation is 0.1 percent or less. Absolute exactness is often better than with the calibration curve. In order to reduce sampling errors and obtain sufficiently large marks, samples of relatively large volume (40 cm^3) are used.

Oil content determination. HOPKINS (1965) writes about determining the oil content of oilseeds seed by seed with the broad-line NMR method applied. A technique similar to that used for the water content determination of "solids" was developed by CONWAY—EARLE (1964) for the determination of oil content in intact seeds. This method requires the total removal of the water content from the seeds (by drying for 16—60 hours at 50° C) prior to the NMR spectrum being taken. The total hydrogen content of oil is proportional with the amplitude of the NMR mark. The shape of the mark is similar to the curve seen in Fig. 4. The shape of the mark is influenced by the composition, saturation of the oil and the amount of oxigenized acids. "Bound" hydrogen which is not in the oil does not cause trouble. The authors calculated the hydrogen content of oils for many seeds by using the earlier determined composition of fatty acids in the respective seeds. The results showed that oil contents determined with the NMR-technique corresponded to those determined with traditional methods.

Determination of nitrogen compounds. The spin of the ^{14}N isotop of 96.635 percent natural frequency is $I = 1$, while that of ^{15}N which has a natural frequency of 0.365 percent is $I = 1/2$. Both are used when chemical problems are investigated. The chemical shift of ^{14}N

was first observed by PROCTOR—YU (1951), later by MASUDA—KANDA (1953) and HOLDER—KLEIN (1955), with NO_3 used as a standard. The NMR marks of ^{14}N are very broad due to the electric quadrupole momentum. Since the electric quadrupole relaxation depends on the electric field gradient in an inverse ratio to the cube of the distance, the broadening of the NMR mark caused by it is highly reactive to the chemical form of ^{14}N. E.g. there is a difference in the width of the NMR-mark between the ^{14}N of dry ammonia and that of NH_4. A similar phenomenon can be seen in Fig. 5.

We have given a brief survey on the applicability of NMR spectroscopy in agricultural research work. The literary data unequivocally show that there are fields where it can be used as a supplementary technique beside the traditional methods, and there are special fields — e.g. the determination of oil content in seeds — where it is the only method that can be used.

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PHYSIOLOGICAL STUDY ON THE EFFECT OF COLCHICINE ON FLAX GROWTH AND DEVELOPMENT VARIETY GIZA 4

In the present paper some data are presented about the effect of colchicine on the growth and development of flax.

The experiments were carried out in pots, 40 cm diameter, in a wire proof green-house at Giza Research Station during the successive seasons of 1969 and 1970. Ten treatments with four replications for each treatment were prepared. Each pot contained 11 kg of loamy soil to which was added 5.5 g of superphosphate, 3 g of ammonium nitrate and 2.5 g potassium chloride before sowing.

30—35 flax plants (var. Giza 4) were sprayed at growing, growing and flowering and at growing flowering and fruiting stages with 250 ml of 50, 100 and20 0 ppm colchicine solution (Sandoz) mixed with 0.05% deterhon as a spreader.

Spraying at growing stages with	50 ppm
	100 ppm
	200 ppm
Spraying at growing and flowering stages with	50 ppm
	100 ppm
	200 ppm
Spraying at growing flowering and fruiting stages with	50 ppm
	100 ppm
	200 ppm

The length of the plants as well as other phenological factors were determined in both treated and control plants during the growing, flowering, fruiting and maturity stages. The yield and oil content of the seeds (Sohkselet modified by FAHMY 1970) were also estimated. Data were statistically analysed.

Effect on plant length. The colchicine applied at the growing stage increased the plant length by about 12—18%. The same applied at the period of flowering and fruiting, however, inhibited it (Table 1). The results were less significant.

Effect on yield. Table 2 shows that spraying flax once at the growing stage or twice at growing and flowering stages with 100 and 200 ppm concentrations of colchicine, increased the number of branches and the weight of the fruits.

No effect of the colchicine treatment could be observed on the plant weight.

As a result of colchicine treatment a decrease both in the weight of 1000 seeds and in the oil content of seeds could also be observed.

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Prepared by the Physiology and Crop Nutrition Department, Ministry of Agriculture, Giza, Orman

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Table 1

The effect of colchicine on the plant length

Treatments, period of measuring	After 1st spray	Growing stage	After 2nd spray	Flowering stage	After 3rd spray	Maturity stage
Control	30 ± 1.3	42 ± 2.0	60 ± 3.0	64 ± 3.0	67 ± 3.0	69 ± 3.0
One time spray with						
50 ppm	35 ± 1.5	48 ± 2.0	58 ± 2.4	62 ± 3.0	66 ± 3.0	70 ± 3.1
100 ppm	36 ± 1.3	50 ± 2.4	60 ± 3.0	65 ± 3.0	69 ± 2.7	73 ± 3.1
200 ppm	37 ± 1.3	50 ± 2.2	61 ± 3.0	65 ± 3.0	68 ± 3.0	71 ± 3.1
Two times spray with						
50 ppm	36 ± 1.5	46 ± 2.2	58 ± 2.4	63 ± 2.7	67 ± 3.1	71 ± 3.0
100 ppm	37 ± 1.5	48 ± 2.2	58 ± 2.4	62 ± 2.7	66 ± 3.1	70 ± 3.0
200 ppm	37 ± 1.6	46 ± 2.4	60 ± 3.0	65 ± 3.0	71 ± 3.0	72 ± 2.7
Three times spray with						
50 ppm	39 ± 1.7	45 ± 2.4	55 ± 2.0	59 ± 3.0	63 ± 3.2	66 ± 3.1
100 ppm	38 ± 1.7	45 ± 2.4	58 ± 2.0	61 ± 2.7	66 ± 3.2	69 ± 2.7
200 ppm	39 ± 1.8	46 ± 2.2	55 ± 2.7	59 ± 2.3	64 ± 3.0	69 ± 3.1

Table 2

The effect of Colchicine on the plant-weight and on the % of oil in the seeds

Treatment	Number of branches	Weight of 10 plants (without fruits) g	Weight of fruits (10 plants) g	Absolute weight of 1000 seeds g	% of oil in seeds
Control	2	8.0	3.5	6.52	33.5
One time spray with					
50 ppm	3	7.0	3.5	6.25	33.0
100 ppm	5	8.0	3.0	7.37	33.0
200 ppm	6	12.0	6.0	6.36	32.0
Two times spray with					
50 ppm	4	10.0	4.0	6.56	32.5
100 ppm	7	9.0	5.0	5.70	32.0
200 ppm	9	11.0	5.0	5.80	31.5
Three times spray with					
50 ppm	4	9.0	4.0	6.26	32.5
100 ppm	6	9.0	5.0	5.73	30.5
200 ppm	9	10.0	5.0	5.63	30.5
LSD sprays					
5%		—	—		
1%		—	—		
LSD concentration					
5%		—	1.63		
1%		—	2.20		
LSD spray Xconcen					
5%		2.65	0.94		
1%		3.56	1.26		

STUDY OF WHEAT VARIETIES GROWN WITH DIFFERENT SPACING

Many experiments aimed at determining the seed-grain requirement of wheat have been carried out all over the world. Seed-grain optima of wheat varieties have been determined under various climatic and ecological conditions.

Many authors are of the opinion that wheat varieties have special spacing requirements. This opinion is, however, hardly — if at all — supported by experimental data. According to LUKYANENKO (1967) spacing requirements range between very wide limits. "Germ numbers of varieties resulted in no significant grain yield differences either in the individual crop years or on the average of the years examined" (KOLTAY 1966).

Frideczky (1939) and Foussard (1961) are of the opinion that the required amount of seedgrain can be considerably reduced by the utilization of stooling.

In experiments performed by Posgay (1961) and Goltin–Novak (1961) with the varieties Bánkúti 1201 and San Pastore respectively, too dense sowing resulted in reduced yields.

In our experiments we studied the following questions from a breeding–methodological point of view.

- What is the response given by differently stooling varieties to spacing, have they any special reaction to spacing?
- To what extent can the relation of productivity to spacing be evaluated?

The following varieties were used in our experiments:

poorly stooling:	Besostaya 1 Szk 3 × Produttore 6 (strain)
intensively stooling:	Fertődi 293 Mironovskaya 808 Fleischmann 481

Unlike the methods of agrotechnical trials the varieties were studied at spacings ranging between very wide limits. They were:

1. 800 grains/m^2 = 10 × 1.25 cm row- and plant distance
2. 400 ,, = 10 × 2.5 cm ,,
3. 200 ,, = 10 × 5.0 cm ,,
4. 67 ,, = 10 × 15.0 cm ,,

The experiments were carried out at Martonvásár in 1.2 m^2 plots of fertile soil, with five replications, between 1965 and 1967. Each year the grains were sown in October, between 20th and 25th.

Crop results obtained each year and their means are shown in Table 1.

By summing up the results of the three years' experiment we found a special response to spacing, according to which Besostaya 1, Fertődi 293 and Szk 3 × Prod. 6 could be classified into the same group. These varieties gave the highest yields with the closest spacing. When sown at a spacing specified under 2, their yields were proportionally lower; they gave the same response to the reduced amount of seed-grain.

With the third spacing, however, — which means half the usual amount of seed-grain — they show different trends. Yields of Besostaya 1 and Szk 3 × Prod. 6 decreased to 84.2 and 80.7 per cent respectively, while that of Fertődi 293 only to 90.2 when compared to yields obtained with the closest spacing. The latter was, thus, more able to make use of a wider spacing. This phenomenon shows the high plasticity of the variety.

The second group includes Mironovskaya 808 which gives the highest yield at spacing 2, with 400 grains/m^2 sown. The closest spacing caused a significant yield decrease in this variety, while spacing 3 resulted in a yield similar to that obtained with spacing 1; its reaction to any further increase in spacing was the lowest of all varieties examined.

Response given by the variety Fleischmann 481 to spacing was similar to that of Mironovskaya 808. In two of the three years it gave lower yields with the closest spacing than with spacing 2. Though the extent of its yield decrease was not as great as that in Mironovskaya 808, it was of a similar type. Its response given to any further increase in spacing was also the same as that of Mironovskaya 808.

Table 1

Yield results of spacing experiments, 1965—67

Variety	Spacing	Yield dkg			Mean	%
		1965	1966	1967		
Besostaya 1	10×1.25	72.6	57.7	51.2	60.5	100.0
	10×2.5	66.6	59.0	46.2	57.2	94.5
	10×5	62.2	52.5	38.4	51.0	84.2
	10×15	37.4	32.9	23.8	31.3	51.7
Fertődi 293	10×1.25	81.0	61.0	43.2	61.7	100.0
	10×2.5	73.4	62.0	34.0	56.4	91.4
	10×5	70.2	60.7	36.4	55.7	90.2
	10×15	46.8	39.0	24.0	36.6	59.3
Mironovskaya 808	10×1.25	52.6	46.7	46.6	48.6	100.0
	10×2.5	54.4	64.8	46.6	55.2	113.5
	10×5	57.0	49.2	38.0	48.0	98.7
	10×15	39.6	41.8	23.6	35.0	72.0
Szk. × Prod. 6	10×1.25	59.6	61.8	53.6	58.3	100.0
	10×2.5	59.0	59.8	41.0	53.2	91.2
	10×5	56.4	54.3	30.6	47.1	80.7
	10×15	39.4	31.7	18.0	29.7	50.9
F. 481	10×1.25	74.4	55.8	37.4	55.8	100.0
	10×2.5	69.4	57.5	41.8	56.2	100.7
	10×5	66.0	55.1	35.8	52.3	93.7
	10×15	42.4	38.5	25.4	35.4	63.4
LSD 5%		3.4	3.3	2.0	2.9	
1%		4.5	4.3	2.6	3.8	

Thus, data obtained show that wheat varieties give specific responses to spacing. Too close spacing causes yield decreases in the intensively stooling varieties. According to data obtained in 1966, with 800 grains sown per m^2 any of the varieties examined may have lower yields under too favourable climatic and agrotechnical conditions. This phenomenon can be observed, however, with too close or too wide spacing only.

If we look at the response given to spacing from the point of view of breeding, we find that with the closest spacing it is the poorly stooling varieties, while with wider spacing the intensively stooling ones that are superior. On the three years average spacing caused no significant changes in the order of succession of the varieties. Great differences were found, however, between the individual crop years, as shown by the data of Fertődi 293 obtained in 1965 and 1967 (Table 2).

In the order of succession determined on the basis of the three years experiments compared with that found each year, spacing at 10×5 cm shows the highest similarity (200 grains/m^2). (The order of succession in the separate years indicates an interaction of genotype×year too.) This spacing, on the other hand, corresponds on the three years average

Table 2

Order of succession of varieties with different spacings

Spacing	Order	Variety	Yield in 1965 %	Variety	Yield in 1966 %	Variety	Yield in 1967 %	Variety	Average yield %
	1	F 293	100	F 293	100	Szk × Prod	100	F 293	100
	2	F 481	92	Szk × Prod	100	Bez. 1	96	Bez. 1	98
10×1.25	3	Bez. 1	90	Bez. 1	92	Mir. 808	87	Szk × Prod	94
	4	Szk × Prod	73	F 481	90	F 293	81	F 481	90
	5	Mir. 808	65	Mir. 808	76	F 481	66	Mir. 808	79
	1	F 293	100	Mir. 808	100	Mir. 808	100	Bez. 1	100
	2	F 481	94	F 293	97	Bez. 1	100	F 293	99
10×2.5	3	Bez. 1	91	Szk × Prod	94	F 281	91	F 481	98
	4	Szk × Prod	80	Bez. 1	92	Szk × Prod	89	Mir. 808	97
	5	Mir. 808	74	F 481	89	F 293	74	Szk × Prod	93
	1	F 293	100	F 293	100	Bez. 1	100	F 293	100
	2	F 481	90	F 481	90	Mir. 808	100	F 481	93
10×5	3	Bez. 1	89	Bez. 1	88	F 293	95	Bez. 1	90
	4	Mir. 808	81	Szk × Prod	87	F 481	95	Mir. 808	85
	5	Szk × Prod	80	Mir. 808	80	Szk × Prod	79	Szk × Prod	84
	1	F 293	100	Mir. 808	100	F 481	100	F 293	100
	2	F 481	90	F 293	95	F 293	96	F 481	97
10×15	3	Mir. 808	85	F 481	93	Bez. 1	88	Mir. 808	96
	4	Szk × Prod	84	Bez. 1	80	Mir. 808	80	Bez. 1	86
	5	Bez. 1	80	Szk × Prod	71	Szk × Prod	72	Szk × Prod	81

to the spacing of 10×2.5 cm (400 grains/m^2), only Besostaya 1 changes its place. At a spacing of 10×2.5 cm differences between the varieties were lower.

To sum up, in small plot (1.2 m^2) experiments carried on for several years, with a spacing of 10×5 cm and under favourable agrotechnical conditions, the productivity of varieties or strains can be precisely determined with practically half the usual amount of seed-grain. Thus the method can be efficiently used in wheat breeding.

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EVAPOTRANSPIRATION, EVAPORATION AND TRANSPIRATION OF RICE CULTURE

The study was conducted during the years 1968 and 1969, at the State Farm, Mezőtúr, a typical rice growing area of the Hungarian Great Plain. The equipments used were galvanized iron tanks having an area of 2500 sq.cms. The tanks were embedded in the centre of the rice field at two water depths, that is 5 and 20 cms blocks, replicated 4 times each. One tank was also kept without growing any plants. ET was measured daily using the Héni-Tóth gauge. The difference between the two was treated as transpiration.

The amount of water lost by various means during the rice growing season at 5 and 20 cms water depths is presented in Table 1.

It is observed that the total ET varies depending upon the depth of water. The tendency for the ET to be greater during the year 1969 reflects upon the slightly longer irrigation period and ET rates. Direct adoption of seasonal RT for rice should only be made for similar climatic zones, in which planting and maturity dates are similar. This clearly illustrates the influence of the duration of a growing season on the total ET for rice.

Transpiration is only about one-third of the ET. Variation is comparatively more for evaporation losses than by transpiration.

Variation in daily ET, E and T during the rice growing periods are shown in Fig. 1. The trends of changes are the same at both the water depths. The amount transpired by the leaves is small immediately after flooding, becomes larger towards tillering, and reaches the peak at about the heading and flowering stages, and then decreases gradually during the ripening stage. The amount of E from the water surface of the rice field is maximum at the time of the beginning of flooding, but decreases with the growth of stalk and reaches the minimum during the later stages, during which the field is fully covered by the crops. Thus there is an opposing relation between due to the mulch action of the plant itself, E from the water surface and transpiration. The variation in ET is influenced by the evaporative demand, rather than by the growing stage of the rice crop. Peak ET rates reported at the time of flowering appear to be more of an association between the energy supply and the leaf cover at the time, than a direct physiological effect on water transport within the plant. This is quite evident in Fig. 1. The rate of ET during the flowering stage of rice, for example, may be only

Table 1

The amount of water lost by various means during the rice growing season

Item	1968		1969	
	5 cms	20 cms	5 cms	20 cms
Irrigation period (Days)	99	99	107	107
Total ET (mms)	488	521	560	594
Transpiration T (mms)	130	151	120	119
Evaporation E (mms)	357	370	440	475
Average daily ET (mms)	4.9	5.3	5.2	5.6
,, ,, T (mms)	1.3	1.5	1.1	1.2
,, ,, E (mms)	3.6	3.7	4.1	4.4
T in percentage	27	29	21	22
E ,, ...	73	71	79	78

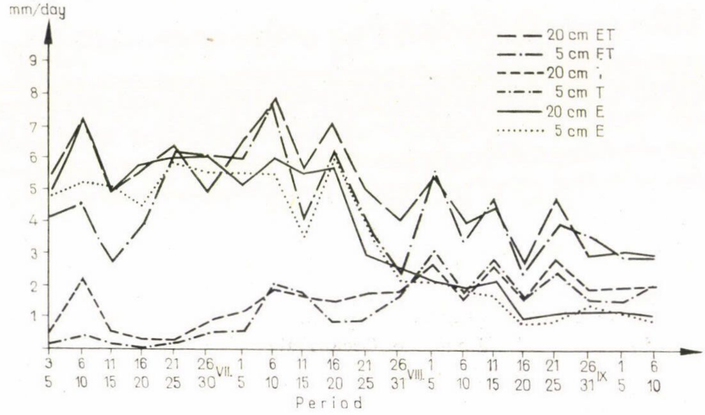

Fig. 1. Variation in daily ET, E and T (1968)

very small, if this stage occurs in May but may be high if it occurs in July. This difference is not due to the characterization of the crops, but is primarily due to the difference in the evaporative demand during the growth stage. All differences in ET rates reported (PETRASOVITS 1957) should be considered in this respect.

Relation between transpiration and plant factors. Relation between the transpiration amount and the leaf area index is shown in Fig. 2.

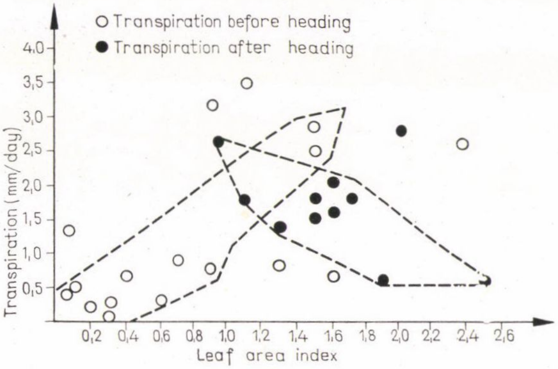

Fig. 2. The relation between leaf area index and transpiration

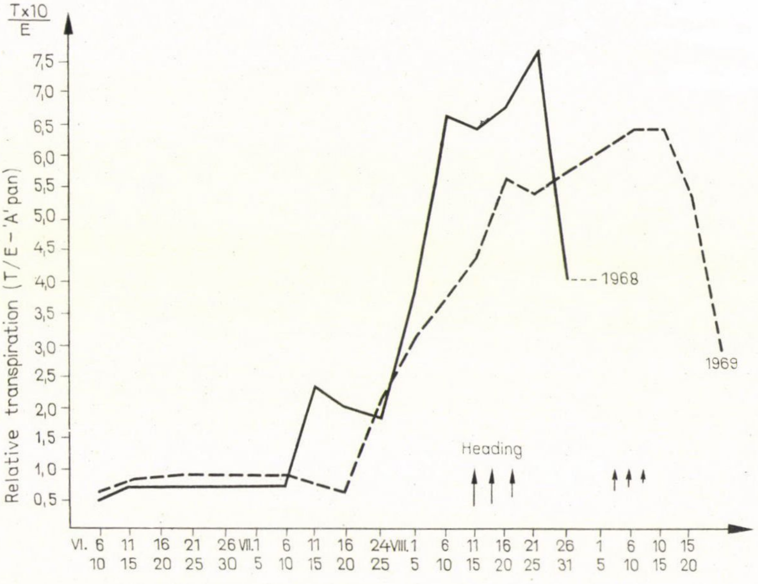

Fig. 3. Seasonal changes of relative transpiration

It is observed that the transpiration amount generally increases with the increase of the leaf area index. But it does not increase after the green cover formation and flowering. Therefore it can be said that the transpiration amount is mainly dominated by the leaf area among the crop factors before green cover formation and is affected mainly by the meteorological factors after the green cover formation.

The seasonal changes of relative transpiration curve (in which the transpiration amount is divided by "A" pan evaporation to avoid the effects of climatic factors) are depicted in Fig. 3. It is observed that T/E ratio gradually increases as the plants grow, but decreases a little before heading, and then falls conspicuously. This tendency is more or less obvious during both the years as has been reported in the literature (ICHIRO *et al.* 1967). Thus the relative transpiration curve figures a bimodel curve.

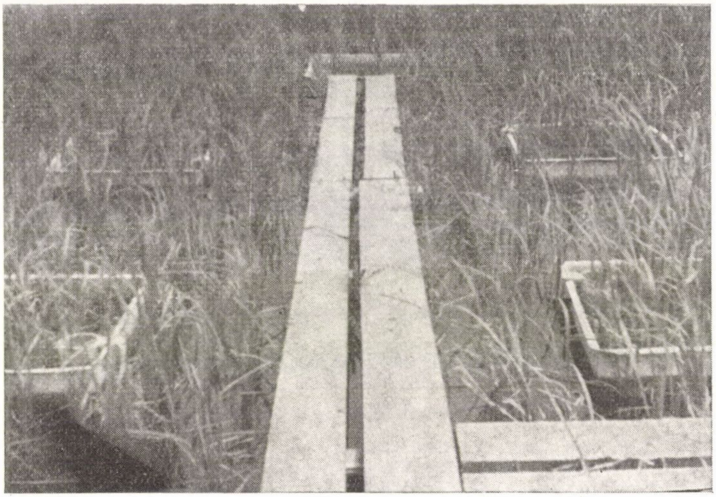

Fig. 4. A view of the tanks set in the rice field to measure evapotranspiration

In this connection, it may also be mentioned that water loss from the water surface covered with rice plants, consists of transpiration from plants and evaporation from the water surface. This combined loss is called ET. Evaporation from the water surface with plants minus evaporation from the water surface without plants is not equivalent to transpiration as such. The shading effect of the foliage of the plants helps to cover the water surface, and hence less amount of evaporation occurs. Subsequently the plants completely cover the ground, and transpiration from the plant surfaces predominates. It is therefore necessary to consider ET as a single loss. Moreover, the same energy is used for both the processes (PENMAN 1948).

*

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INVESTIGATIONS INTO PLANT CULTIVATION CHARACTERISTICS AND APPLICATION OF RESULTS IN COMBINE HARVESTER OPERATION I

Investigations into the behaviour of cereals in threshing procedures led to the conclusion that individual varieties differ more widely than whole species in threshing behaviour. Physiological and morphological constitutions of two wheat varieties may in some circumstances cause threshing behaviour differences that are far more marked than those between wheat and rye.

G. D. R. public authorities in charge of variety grading therefore decided to have investigations carried out in the spheres of plant physiology, morphology, and agrobiology to test the consistency of individual varieties.

These indices and parameters of plant constitution are vital essentials required for optimization of conditions involved in partially or fully mechanized harvesting procedures. As a first step the physiological indices of individual varieties and species had to be classified. This method allowed varieties that appeared to be less suitable for fully mechanized harvesting in view of their consistency levels to be recognized and taken out of cultivation step by step. Varieties with features that make them particularly preferable for fully mechanized production were selected and cultivation and development of seeds was given special attention.

Evaluated in terms of loss reduction and quality improvement over subsequent years the problem was shown to have been correctly defined.

When combine harvesters were introduced, the harvesting losses were as high as 5 to 8 per cent, in some cases even 10 per cent. Quality reductions (grain breakage) occurred in 5 to 10 per cent, while reduced germinative capacity was observed in up to 20 per cent of the yield. In cases of large-grained and small-grained legumes quality reductions involved even up to 70 per cent of the yield, and even whole-scale damage due to complete destruction of germinative faculty was discovered. In addition there was usually a 20 to 30 per cent loss in combine harvester capacity due to the inadequate adjustment of the operating elements to cereal consistency.

Steps were taken to try and eliminate these disadvantages in a complex way, i.e. by dealing with cultivation, variety and machinery. The results obtained for individual varieties by investigation in terms of plant physiology and consistency were one of the necessary conditions.

Knowledge of these characteristics allowed the selection and predominant cultivation of varieties particularly suited to combine harvesting. This opened the way to the adaptation of machinery to grain consistency.

Experience showed that in the future seed experts, plant physiologists, and agricultural engineers (i.e. designers and production engineers) will have to co-operate in order to gain maximum insight into mechanizing problems, too, from data concerning agrobiology, plant biology and morphology.

Method of investigation

Combine harvesting variety tests. A specially established variety test station for combine harvester crops grew all varieties of cereals and a number of other important combine-harvested crops on trial fields. The entire range of investigations involving the above mentioned problems were performed in the course of harvesting operations.

The following investigations were made:

Biological tests. Beginning directly after sowing continual classifications were made to determine plant growth and find out interrelations between growth proceedings and harvesting operations. When ripeness was approaching daily straw and grain moisture-conten-measurements were performed to establish ripening progress indices. This allowed the earliest harvesting dates to be fixed for every variety.

Beaters and laboratory-type threshing drums were used to investigate how grains still humid and approaching terminal ripeness responded to mechanical action and which level of power was required to release grain from ears. Threshing tests were spread over the entire harvesting period in order to fix the optimum harvesting dates.

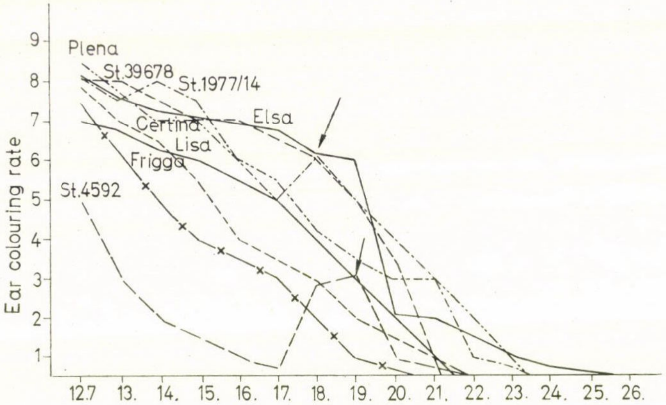

Fig. 1. **Eosin deposition curves applicable to determine terminal ripening**

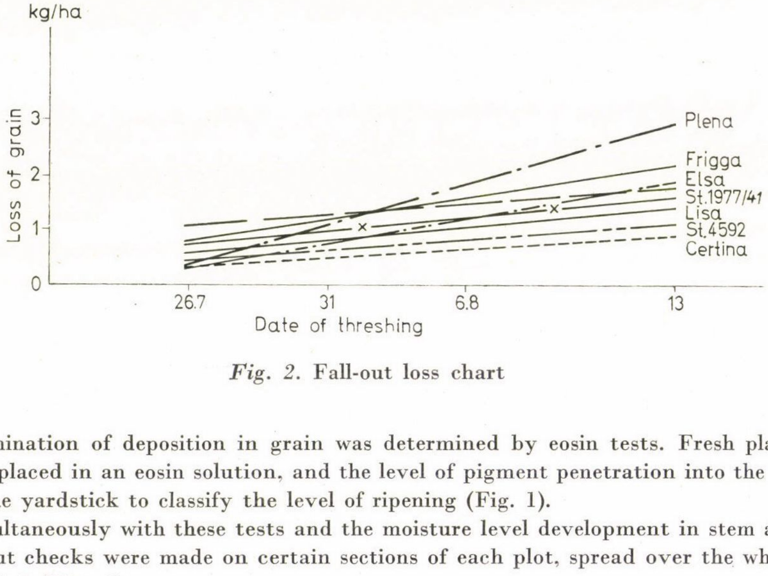

Fig. 2. Fall-out loss chart

Termination of deposition in grain was determined by eosin tests. Fresh plants cut daily were placed in an eosin solution, and the level of pigment penetration into the ear was taken as the yardstick to classify the level of ripening (Fig. 1).

Simultaneously with these tests and the moisture level development in stem and ears daily fall-out checks were made on certain sections of each plot, spread over the whole harvesting period (Fig. 2).

Further investigations were directed at growth densities and the differences observed. It was well known that non-uniform feeding of crop to threshing gear results in disadvantages involving higher losses, reduced capacity and lower quality. Growth density variations of more than 100 per cent could be analyzed in these investigations (Fig. 3).

Other investigations analyzed stem thickness, buckling tendencies in ears, stem collapse, i.e. lodging of crops or ears, respectively, on the ground, general brittleness of straw with resulting short fragmentation (chopping) of straw, and displacement of shakers and screens.

Technical plant tests. A wide range of technical tests were performed during threshing. There were principal threshing tests done involving early ripeness, a stage of medium ripening, as well as late ripening. In the further course of tests these investigations were conducted at five different stages or times, respectively, including absolutely early threshing of barely ripened grain and a test involving overripe grain at a time when ordinarily harvesting had been finished for some time (i.e. a fortnight after the latest harvesting date). The first and the last test mentioned above indicated which variety might be harvested prematurely at moderate losses, and which might still be harvested at a rather late date if required due to weather conditions.

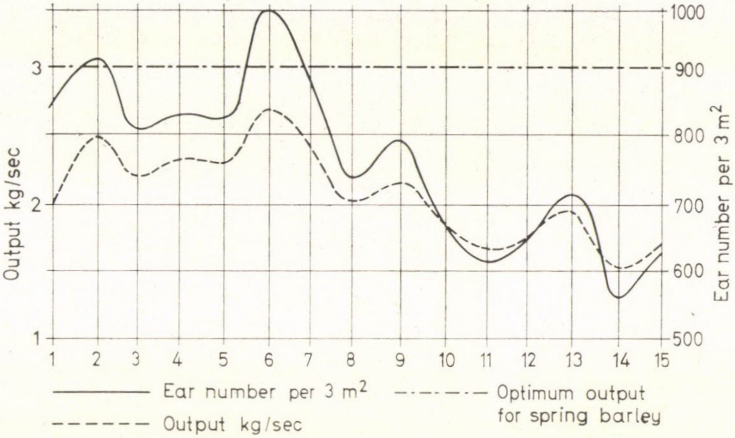

Fig. 3. Growth density and throughput variations

Threshing runs were used to check chaff losses, drum losses (i.e. the percentage of grain not released), scattering losses, and maximum throughput capacity. Investigations also covered the threshing of grain with maximum, medium or minimum moisture contents.

With the use of the data thus obtained a technological chart dealing with individual varieties could be drawn up. A most preferable harvesting period could be established for every variety (Fig. 4). As a result of this harvesting period classification the individual varieties were regionalized so that one early-harvesting and one late-harvesting variety each became available to farmers of every region involved.

Harvesting peaks due to grain ripening conditions were reduced and any varieties found not suitable for combine harvesting were eliminated, e.g. varieties having fall-out and scattering losses of up to 15 per cent at the beginning of the combine harvesting period.

The farmers' demands for stable varieties not affected by fall-out tendencies had, on the other hand, also resulted in the cultivation of varieties whose grains were so firmly seated that combine harvesting was feasible at very late dates only and with a high percentage of grain not released from ears. These strains were also eliminated from the assortment. Similar measures were taken with regard to legumes having high damage quota.

In addition, physiological tests systematically indicated to seed experts the limits of plant consistency based on economic considerations.

Data obtained resulted in revised targets for seed cultivation involving new combine harvester crop varieties.

For practical farming purposes it is also preferable to have varieties distributed according to the expected harvesting periods. Grain harvest network planning applied in the German

Democratic Republic is largely based on the agrobiological research work and the results stated above.

This, however, did not by itself solve the problems involved in optimum harvesting machine adjustment in threshing. We therefore took steps to apply the results of plant investigation to technological and technical conditions involved in combine harvester operation.

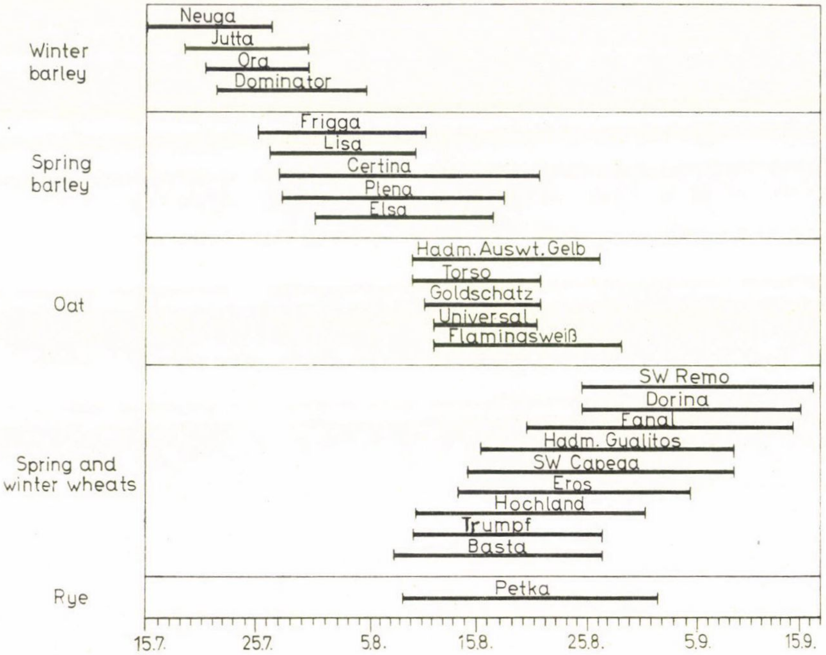

Fig. 4. Ripening sequence technological chart

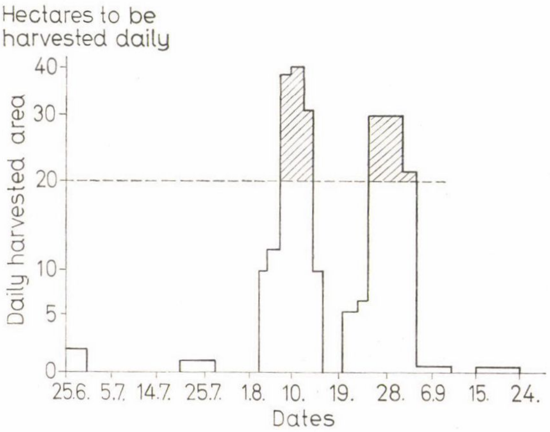

Fig. 5. Work peaks caused by concurrent ripening due to unfavourable growing technique and variety selection

Application of plant consistency data in order to establish the technological parameters involved in fully mechanized harvesting (combine harvester operation). Further development and optimization of technical harvesting parameters (machine setting data) were possible only when essentials for exact comparison and infinitely reproducible test conditions had been defined. Such comparison facilities were not in existence at the time when combine harvesting was being introduced since the machines operated over the entire harvesting period with daily and continually changing and unknown grain consistency data. For each operation the machines had to be set with data established empirically.

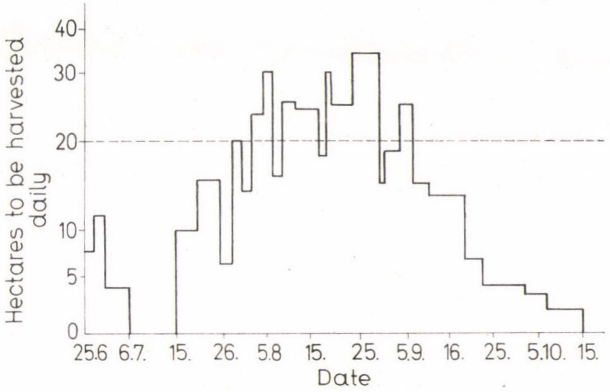

Fig. 6. Work peak elimination by favourable variety selection

Within the framework of technical variety grading we therefore designed a grain test stand where any variety could be tested for resistance to impact or pressure, moisture content, stem tear resistance, cleaning aptitude, or any other characteristic. This arrangement provides a possibility of comparing technical equipment since grain consistencies are known or can be established prior to any test application.

Records of grain consistencies allow certain tests with similar or identical consistencies to be compared even years after.

Test service. Technical setting data for operating elements (e.g. drum speed, shaker frequencies, etc.), which had been established on the test stand in addition to grain consistencies, were then applied to practical farming work and subjected to operational tests.

In addition to variety grading there were further setting data established and checked in test runs performed in summer and winter.

A combine harvester test service was set up for one complete harvesting period to ensure large-scale data verification by test series.

This combine harvester test service was provided with

— optimum data for combine harvester setting established in variety grading and technological operating tests; and

— a method of immediate loss determination.

In addition to application of optimum combine harvester setting data this arrangement allowed immediate subsequent checking of effect. Two hundred specially trained engineers checked a great number of the combine harvesters employed in the German Democratic Republic. They applied the optimum operating data they established to the machine involved, and they checked effectiveness by using the method of immediate loss determination. Data required in the conditions involved were recorded in a test chart.

Data to be recorded by test service engineers had a fairly wide range. Apart from general information such as location, time and date, they included soil conditions, species and variety, the degree of ripeness, moisture levels in grains and straw, the extent of lodging, undergrowth, etc.

Investigations also dealt with shaker and drum losses, scattering losses and losses due to cut-off ears. Speeds of combine harvester operating elements were stated before and after the check. The combine harvester test service was thus able to establish series of data acquired before and after optimization.

A total of about 12,000 data series were recorded, whose evaluation took several years. The material was evaluated according to several considerations, e.g. influence of moisture on setting and losses, influence of ripeness level on setting and losses, influence of moisture and ripeness level on output and capacity, influence of capacity on losses and setting, influence of moisture, ripeness level, and capacity on qualitative threshing results.

The results of these investigations have been published elsewhere. They were the major contributions to the combine harvester setting slide rule, whose reference data have meanwhile proved their applicability in many countries almost without any changes.

Investigation of crop conditions led to the following conclusions:

It is necessary to examine cereal varieties in terms of technological and technical conditions and to keep track of physiological, morphological and general plant consistencies right from initial cultivation in order to eliminate any material unsuitable for full mechanization, and to promote suitable mateiral.

It is useful to draw up a ripening sepuence chart based on variety ripeness test data. Such charts will allow the most preferable harvesting periods to be determined for individual varieties involved. Adequate variety selection and territorial distribution will permit the sequence of harvesting operations to be planned and excess work peak due to concurrent ripening to be avoided.

The data acquired in the plant investigations are to be used for adjustment and setting of combine harvesters.

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SUNFLOWER VARIETY “IREGI KORAI CSIKOS”

Taxonomical place: *Helianthus annuus* L. conv. *simplex* My. cg. *microcarpus* My. cv. *communis* My.

Origin: selected from a commercial population.

Beginning of breeding: 1936, Iregszemcse.

State qualification: state registered improved variety, 1955; first accepted in 1942.

Breeder: Ernő Kurnik dr. and Mrs. Mészáros (Iregszemcse).

General characterization: a sunflower variety of both agricultural and industrial value; medium high, with a higher than average oil production, striped seed-coat; storable without loss.

Morphological description:

Root system: has a strong main root penetrating the soil to about 100–120 cm, with numerous fine laterals.

Shoot system: is free of laterals, develops a single powerful main shoot.

Stem: hypocotyl is generally green, it may have, however, a slight light violet colour; the strong stem is of medium height, about 140–190 cm when maturing; its colour is light yellowish green, surface moderately hairy.

Foliage: on the strong petiole the leaf-blade is heart-shaped-triangular with roughly dentate edges and blunt leaf apex; its colour is dark yellowish green; leaf blade is 25—32 cm long and the main rib is continued in a 19—26 cm long petiole. Cross section made in the middle of the petiole is heart-shaped with a shallow strait (MÁNDY 1962).

Capitulum: generally develops one per each plant (there is little tendency to develop more). The capitulum is 19—20 cm in diameter, slightly drooping. Ligulate florets are of light orange colour. Tubular florets are slender with whitish sepals. Anther tune is dark purplish brown; pistil dark orange-coloured.

Fig. 1

Fruit: achene is dark grey with light stripes, with a phytomelan layer in the pericarp (which makes it resistant to sunflower moth). The weight of thousand achenes is 65—80 g. The proportion of seed to fruit is 56—61 percent, oil content in dry matter 35—37 per cent. Achene is easily stored and does not become rancid even when stored for a long time (KAPÁS *et al.* 1965).

Biological characters:

Germination: seeds germinate well in soils of 12—13° C.

Vegetation period: 120—140 days; initial development rapid.

Water requirement: moderate, evenly distributed precipitation is favourable, abundant rains cause leaf rust infection (KAPÁS *et al.* 1965).

Resistance to disease: susceptible to Orobanche cumana infection; disposed to leaf rust too, but rather resistant to the mouldy rot of stem and capitulum (BAKOS—BÉKÉSI 1968) as well as to peronospora.

Farm technology requirement:

Seeding: at a spacing of 60 × 40 cm; after a wet winter best sown in the second half of April.

Soil requirement: gives good yield results in any kind of fertile soil except sand- and heavy soils (KAPÁS *et al.* 1965).

Productivity: seed production sufficient, an average of 38 q/ha of which oil production is 14.2 q/ha (BAKOS—BÉKÉSI 1968).

Region of cultivation: the southern and south-eastern parts of Hungary and the total area of the Great Plain.

*

Prepared at the Department of Botany, University of Agricultural Sciences, Debrecen

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FORUM

EFFECT OF BENZYLADENINE ON THE AMOUNT OF LEAF PIGMENTS IN BEAN

Leaf pigment response to benzyladenine treatment was studied in cuttings of the bean variety Fertődi 5 when kept in dark and under permanent illumination respectively. The pigments were separated on a cellulose layer (MN 300) and their quantities determined with a spectrophotometer. The benzyladenine treatment was efficient exclusively in preserving the chlorophyll content of shoots kept in dark. At the same time under such conditions it accelerated the decomposition of the neoxanthin. In shoots kept under permanent illumination the rate of chlorophyll- and carotenoid decomposition showed a definite parallelism — irrespective of the treatment. This phenomenon can be brought into connection with the protective effect of carotenoids against photodestruction. Comparison of the literature and our data suggests that the "feedback" system ensures the balance between chlorophyll and carotenoids in plants exposed to light.

Introduction

Shoots and leaves removed from plants display an accelerated senescence, especially when these plant parts are kept in the dark. This process can be followed with the unaided eye, as these plant parts gradually lose their chlorophyll content and eventually turn yellow. The rate of chlorophyll decomposition can be slowed down with cytokinins among others, although species show different reactions to various cytokinins.

For example kinetin, a typical though not natural cytokinin, definitely inhibited the chlorophyll decomposition in isolated leaves of *Xanthium* (Richmond—Lang 1957), oats (Gunning—Barkley 1963), radish (Burdett—Wareing 1966) and maize (Knypl 1967). Another cytokinin: the benzyladenine exerted a similar effect on isolated leaves of rice and peanut (Mishra—Misra 1968) while inhibited the chlorophyll degradation of "Red Kidney" bean leaves but to a low extent (Goldthwaite—Laetsch 1967).

Much less is known, however, about what happens at the same time to the carotenoids — these permanent concomitants of the chlorophylls. We have found only a single paper (Gaspar—Xhaufflaire 1968) which also deals with the effect of cytokinins on the amount of carotenoids. Extension of investigations into this subject is justified by the fact that on the basis of results obtained with carotenoid mutants (Griffiths *et al.* 1955, Frank—Kenney 1955, Anderson—Robertson 1959, Faludi-Dániel—Láng 1964) carotenoids are thought to have a protective effect against photodestruction.

Material and Method

Seeds of the bean variety Fertődi 5 were sown into peat and sand mixed at a ratio of 1 : 3. The seedlings were kept at temperatures of 18—20° C with a permanent illumination of 4200 lux intensity until used in the experiment 8 days after sowing. Light was provided by low pressure mercury vapour lamps. Cuttings with 3 cm long hypocotyls were made of the

Table 1

Changes in the amount of certain leaf pigments of the bean variet

Treatment		Chlorophyll *a*	Chlorophyll *b*	$\frac{\text{Chlorophyll } a}{\text{Chlorophyll } b}$	Total Chlorophyll
At the beginning of the experiment		954.02 ± 246.50	388.10 ± 81.84	2.44 ± 0.13	1342.12 ± 318.34
	Percentage distribution	71.1 ± 18.4	28.9 ± 6.1		100.0
	As related to the initial amount	100.0 ± 25.8	100.0 ± 21.1		100.0 ± 24.5
Distilled water		341.45 ± 89.63	128.36 ± 30.84	2.64 ± 0.06	469.81 ± 120.47
	Percentage distribution	72.7 ± 19.1	27.3 ± 6.6		100.0
	As related to the initial amount	35.8 ± 9.4	33.1 ± 7.9		35.0 ± 9.0
Benzyladenine 5 ppm.		517.78 ± 92.60	209.20 ± 42.23	2.49 ± 0.09	726.98 ± 134.83
	Percentage distribution	71.2 ± 12.7	28.8 ± 5.8		100.0
	As related to the initial amount	54.3 ± 9.7	53.9 ± 10.9		54.2 ± 10.0

seedlings (2×10 per treatment) then the cotyledons removed. The cuttings were put into test tubes filled with distilled water, then kept permanently in the dark or placed into a growth chamber with constant illumination (4200 lux) — in accordance with the treatment. During the experiment the temperature ranged between 18 and 20° C. The cuttings were treated every second day: 5 ppm solution of benzyladenine was spread over the upper surface of each primary leaf. Control plants were treated with distilled water. The time of the evaluation was determined by the visible signs of chlorophyll decomposition. With shoots kept in dark this occurred after 5—8 days, while with those illuminated after 10—15 days. Leaf samples

Fertődi 5 kept in darkness μ/g fresh weigh

Lutein	Viola-xanthin	Neo-xanthin	Total xanthophylls	Carotenes	Total carotenoids	Xanthophylls / carotenes	Chlorophylls / carotenoids
107.35 ± 23.91	27.43 ± 6.94	33.54 ± 5.50	168.32 ± 36.35	80.22 ± 23.94	248.54 ± 60.29	2.20 ± 0.24	5.55 ± 0.71
43.2 ± 9.6	11.0 ± 2.8	13.5 ± 2.2	67.7	32.3 ± 9.6	100.0		
100.0 ± 22.3	100.0 ± 25.3	100.0 ± 16.4	100.0 ± 21.6	100.0 ± 29.8	100.0 ± 24.3		
80.84 ± 14.81	21.86 ± 2.76	27.53 ± 2.09	130.23 ± 19.66	58.27 ± 9.10	188.50 ± 28.76	2.19 ± 0.12	2.55 ± 0.51
42.9 ± 7.9	11.6 ± 1.5	14.6 ± 1.1	69.1	30.9 ± 4.8	100.0		
75.3 ± 13.8	79.7 ± 10.1	82.1 ± 6.2	77.4 ± 10.1	72.6 ± 11.3	75.8 ± 6.2		
72.71 ± 18.55	21.22 ± 4.14	21.35 ± 4.67	115.28 ± 27.36	53.72 ± 9.10	169.0 ± 36.4	2.12 ± 0.25	4.35 ± 0.39
43.0 ± 11.0	12.6 ± 2.4	12.6 ± 2.8	68.7	31.3 ± 5.4	100.0		
67.7 ± 17.3	77.4 ± 15.1	63.7 ± 13.9	68.5 ± 16.3	67.0 ± 11.3	68.0 ± 14.7		

of an average of 1 g each were taken per replication. Leaves were dipped for 20 seconds into hot water in order to make extraction quicker. According to the evidence of preliminary experiments this heat treatment does no harm to the pigments. Then leaves were cut with a razor blade into tiny pieces and extracted with acetone (20 + 10 ml) in the dark on two subsequent occasions. Immediately after the process of extraction completed the pigments were separated on a 20 × 20 cm cellulose layer (Macherey-Nagel 300). Chromatography was, in essentials, carried out after the method applied by SCHNEIDER (1966), with the difference that the ratio of components in the solvent had to be changed by applying the ratio of methanol : dichloromethane : water = 100 : 18 : 13 instead of 100 : 18 : 20.

Table 2

Changes in the amount of certain leaf pigments of the bean variety

Treatment		Chlorophyll *a*	Chlorophyll *b*	Total chlorophyll
At the beginning of the experiment		7333.51 ± 3873.73	3561.11 ± 804.95	10894.62 ± 4678.68
	Percentage distribution	67.3 ± 35.6	32.7 ± 7.4	100.0
	Percentage as related to the initial amount	100.0 ± 52.8	100.0 ± 22.6	100.0 ± 42.9
Distilled water		3558.73 ± 1694.47	1337.59 ± 614.94	4896.32 ± 2309.41
	Percentage distribution	72.7 ± 34.6	27.3 ± 12.6	100.0
	Percentage as related to the initial amount	48.52 ± 23.1	37.6 ± 17.3	44.9 ± 25.2
Benzyladenine 5 ppm		6244.16 ± 1270.70	2492.54 ± 416.12	8736.70 ± 1686.82
	Percentage distribution	71.5 ± 14.5	28.5 ± 4.8	100.0
	Percentage as related to the initial amount	85.1 ± 17.3	70.0 ± 11.7	80.2 ± 15.5

Two chromatograms per replication, i.e. 4 per treatment were made. The amount of material used was 500 μl per each. The extract was applied without any air current, since the preliminary experiments had shown about 20 per cent loss of material caused even by a cold air current. The bands were collected in centrifuge tubes; chlorophylls were eluted with peroxide free ether (5 ml), while carotenoids with dimethylformamide (5 ml), and their quanti-

Fertődi 5 kept in darkness (μg/g dry matter)

Lutein	Violaxanthin	Neoxanthin	Total xanthophylls	Carotenes	Total carotenoids
987.69 ± 235.57	255.46 ± 81.73	310.77 ± 58.72	1553.92 ± 376.02	736.30 ± 232.38	2290.22 ± 608.4
43.1 ± 10.3	11.2 ± 3.6	13.6 ± 2.6	67.9	32.1 ± 10.1	100.0
100.0 ± 23.9	100.0 ± 32.0	100.0 ± 18.9	100.0 ± 24.2	100.0 ± 31.6	100.0 ± 26.6
996.0 ± 142.56	270.78 ± 48.39	339.44 ± 27.07	1606.26 ± 190.95	720.89 ± 89.07	2327.15 ± 307.09
42.8 ± 6.1	11.6 ± 2.1	14.6 ± 1.2	69.0	31.0 ± 3.8	100.0
100.8 ± 14.4	106.0 ± 18.9	109.2 ± 8.7	103.4 ± 12.3	97.9 ± 12.1	101.6 ± 13.4
849.13 ± 125.22	245.99 ± 13.08	245.25 ± 14.56	1340.37 ± 152.86	650.15 ± 115.26	1990.52 ± 268.12
42.7 ± 6.3	12.4 ± 0.7	12.3 ± 0.7	67.3	32.7 ± 5.8	100.0
86.0 ± 12.7	96.3 ± 5.3	76.9 ± 4.7	86.3 ± 9.8	88.3 ± 15.7	86.9 ± 11.7

ties determined by a spectrophotometer (MOM 201). Eluates of cellulose dust collected from below the starting-line were used as standard solution. The quantity of chlorophylls was calculated according to COMAR—ZSCHEILE (1942) while that of the carotenoids with a formula presented by GOODWIN (1955). Under our experimental conditions absorption maxima were found at the following wave lengths (mμ): chlorophyll-a = 660, chlorophyll-b = 642, caro-

Table 3

Changes in the amount of certain leaf pigments

Treatment		Chlorophyll *a*	Chlorophyll *b*	$\frac{\text{Chlorophyll } a}{\text{Chlorophyll } b}$	Total chlorophyll
At the beginning of the experiment		1011.87 ± 164.51	358.98 ± 70.39	2.91 ± 0.11	1370.85 ± 234.9
	Percentage distribution	73.8 ± 12.0	26.2 ± 5.1		100.0
	Percentage as related to the initial amount	100 ± 16.3	100 ± 19.6		100 ± 17.1
Distilled water		538.14 ± 92.44	198.89 ± 27.60	2.70 ± 0.14	737.03 ± 120.04
	Percentage distribution	73.0 ± 12.5	27.0 ± 3.7		100.0
	Percentage as related to the initial amount	53.2 ± 9.1	55.4 ± 7.7		53.8 ± 8.8
Benzyladenine 5 ppm		528.77 ± 75.48	215.62 ± 44.60	2.52 ± 0.16	744.39 ± 120.08
	Percentage distribution	71.0 ± 10.1	29.0 ± 6.0		100.0
	Percentage as related to the initial amount	52.3 ± 7.5	60.1 ± 12.4		54.3 ± 8.8

tenes = 460, lutein = 455, violaxanthin = 450, neoxanthin = 445. Maxima sometimes deviated by ±1–2 mμ from the above figures, therefore around the expected peak we took more than one measurements in order to determine the maxima accurately. Each table comprises the data of 4 experiments. The amounts of leaf pigments determined at the beginning of each experiment were taken as 100 percent and the results of treatments were related to it.

in the bean variety Fertődi 5 kept in light (μg/g fresh weight)

Lutein	Viola-xanthin	Neo-xanthin	Total xanthophylls	Carotenes	Total carotenoids	$\frac{\text{Xanthophylls}}{\text{carotenes}}$	$\frac{\text{Chlorophylls}}{\text{carotenoids}}$
117.11 ± 19.84	33.98 ± 3.22	33.26 ± 7.41	184.35 ± 30.47	83.52 ± 16.18	267.87 ± 46.65	2.23 ± 0.08	5.08 ± 0.04
43.7 ± 7.4	12.7 ± 1.2	12.4 ± 2.8	68.8	31.2 ± 6.0	100.0		
100.0 ± 16.9	100.0 ± 9.5	100.0 ± 22.3	100.0 ± 16.5	100.0 ± 19.4	100.0 ± 17.4		
63.02 ± 18.02	14.73 ± 2.06	21.30 ± 4.20	99.05 ± 24.28	49.65 ± 9.39	148.7 ± 33.67	2.08 ± 0.38	5.08 ± 0.59
42.4 ± 12.1	9.9 ± 1.4	14.3 ± 2.8	66.6	33.4 ± 6.3	100.0		
53.8 ± 15.4	43.7 ± 6.1	64.0 ± 12.6	53.7 ± 13.2	59.4 ± 11.2	55.5 ± 12.6		
64.02 ± 22.53	21.25 ± 6.45	20.69 ± 6.68	105.96 ± 35.66	49.53 ± 10.92	155.49 ± 46.58	2.10 ± 0.19	5.09 ± 0.90
41.2 ± 14.5	13.7 ± 4.1	13.3 ± 4.3	68.1	31.9 ± 7.0	100.0		
54.7 ± 19.2	62.5 ± 19.0	62.2 ± 20.1	57.5 ± 19.3	59.3 ± 13.1	58.0 ± 11.2		

Results

1. Changes of leaf pigment content in bean shoots kept in the dark. Leaves of shoots kept in the dark lost about two-thirds of their chlorophyll content in 5–8 days, while only one-third of the carotenoids was decomposed, and when related to the dry matter content degradation could not even be demonstrated (Table 2). Benzyladenine significantly inhibited decomposition in the chlorophylls, while somewhat accelerated it with the carotenoids, though the latter difference was only significant in the case of neoxanthin. No difference in the in-

Table 4

Changes in the amount of certain leaf pigments in the bean variety

Treatment		Chlorophyll *a*	Chlorophyll *b*	Total chlorophylls
At the beginning of the experiment		7748.54 ± 1303.84	2658.44 ± 427.11	10406.98 ± 1730.95
	Percentage distribution	74.5 ± 16.6	25.5 ± 4.1	100.0
	Percentage as related to the initial amount	100.0 ± 16.8	100.0 ± 16.1	100.0 ± 16.6
Distilled water		3773.22 ± 980.96	1387.43 ± 305.87	5160.65 ± 1286.83
	Percentage distribution	73.1 ± 19.0	26.9 ± 5.9	100.0
	Percentage as related to the initial amount	48.7 ± 12.7	52.2 ± 11.5	49.6 ± 12.4
Benzyladenine 5 ppm		3562.47 ± 864.98	1464.53 ± 449.45	5027.0 ± 1314.43
	Percentage distribution	70.9 ± 17.2	29.1 ± 8.9	100.0
	Percentage as related to the initial amount	46.0 ± 11.2	55.1 ± 16.9	48.3 ± 12.6

tensity of decomposition was proved between chlorophyll-a and chlorophyll-b, or between xanthophylls and carotenoids, on the other hand, the chlorophyll-carotenoid ratio considerably decreased in isolated shoots kept in the dark and treated with distilled water. Benzyladenine maintained the chlorophyll-carotenoid ratio nearly at the starting level.

2. Changes of leaf pigment content in bean shoots kept under permanent illumination. Notwithstanding the expectations benzyladenine did not inhibit decomposition either in chlorophylls or in carotenoids. Since, irrespective of the treatments, the rate of decompositon was similar in chlorophylls and carotenoids, the chlorophyll-carotenoid ratio did not change.

Fertődi 5 kept in light (μg/g dry matter)

Lutein	Violaxanthin	Neoxanthin	Total xanthophylls	Carotenes	Total carotenoids
907.51 ± 123.20	266.85 ± 31.05	258.94 ± 55.50	1433.3 ± 209.75	650.19 ± 120.68	2083.49 ± 330.43
43.6 ± 5.9	12.8 ± 1.5	12.4 ± 2.7	68.8	31.2 ± 5.8	100.0
100.0 ± 13.6	100.0 ± 11.6	100.0 ± 21.4	100.0 ± 14.6	100.0 ± 18.6	100.0 ± 15.9
445.89 ± 148.19	101.23 ± 15.72	156.16 ± 29.43	703.28 ± 193.34	342.06 ± 83.02	1045.34 ± 276.36
42.7 ± 14.2	9.7 ± 1.5	14.9 ± 2.8	67.3	32.7 ± 7.9	100.0
49.1 ± 16.3	37.9 ± 5.9	60.3 ± 11.4	49.1 ± 13.5	52.6 ± 12.8	50.2 ± 13.3
442.68 ± 198.58	143.89 ± 60.18	138.68 ± 54.07	725.25 ± 312.83	333.36 ± 110.46	1058.61 ± 423.29
41.8 ± 18.8	13.6 ± 5.7	13.1 ± 5.1	68.5	31.5 ± 10.4	100.0
48.8 ± 21.9	53.9 ± 22.6	53.6 ± 20.9	50.6 ± 21.8	51.3 ± 17.0	50.8 ± 20.3

In leaves treated with distilled water neoxanthin proved more resistant to photodestruction than the other xanthophylls, though the difference has not been sufficiently proved. In leaves treated with benzyladenine this difference totally disappeared. It is worth mentioning that the decomposition of chlorophyll-a was usually somewhat quicker than that of chlorophyll-b, the difference was not, however, significant.

Discussion

It is not clear with what mechanism benzyladenine inhibits the decomposition of chlorophylls. Some authors suggested a correlation between the disappearance of proteins and that of chlorophylls, because in isolated plant parts or plants kept in the dark degradation of both protein and chlorophyll is extremely intensive (MICHAEL 1935), and at the same time decomposition of both substances can be inhibited with benzyladenine. The above conception is confirmed by a recent discovery, namely, that the chloroplasts contain the chlorophyll in the form of protein-chlorophyll complexes (THOMAS *et al.* 1953, YAKUSHIJI *et al.* 1963).

Literary data available are not, however, unequivocal, nor could we form a uniform opinion on the basis of our own experiments, so we must not get involved in explaining the phenomena.

In our present series of experiments benzyladenine treatment only inhibited chlorophyll decomposition in shoots kept in darkness which suggests that inhibition is in no connection with the photosynthetic processes. It is striking that the same treatment not only did not inhibit the decomposition of carotenoids, but — in contrast with the results obtained by GASPAR—XHAUFFLAIRE (1968) — even stimulated it to some extent. This difference is due to the peculiar behaviour of neoxanthin. Namely, it was with this carotenoid alone that decomposition was significantly quicker in leaves treated with benzyladenine and kept in darkness. Neoxanthin displayed a peculiar attitude in samples kept in light and treated with distilled water too, as it proved more resistant than the other carotenoids. YAMASHITA *et al.* (1969) obtained similar results with isolated spinach chloroplasts *in vitro*.

It was extremely interesting that in leaves kept in light the ratio of chlorophyll- and carotenoid decomposition showed a definite parallelism irrespective of the treatment, that is, the chlorophyll—carotenoid ratio did not change significantly. As no such phenomenon was observed in the case of shoots kept in darkness and treated with distilled water we may well assume that the standard chlorophyll: carotenoid ratio in leaves exposed to light is related to the protective effect of carotenoids against photodestruction. Data of other *in vitro* experiments confirm too that carotenoids are more sensitive to photo-oxidation than chlorophylls (YAMASHITA *et al.* 1969, SAUER—CALVIN 1962). A comparison of literature cited and our data suggests that "feedback" system ensures the balance of chlorophyll and carotenoid in plants exposed to light.

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DOES "MOLECULAR LOCALIZATION" MEAN COMPARTMENTALIZATION?

While the author makes a case for soluble protein changes as an indicator of CO_2 fixation, he fails to discuss the literature on this subject adequately. For example, there is no mention of the influence of chemical treatment or stress on ribulose diphosphate dicarboxylase levels, reported by several workers.

Below are specific questions:

1. What are "Data of cpm/mg chlorophyll"?
2. Does this sentence mean weight chlorophyll per unit weight of tissue or activity of chlorophyll per unit weight of tissue? If the later define specific activity earlier.
3. There is no question of the opening statement of this paragraph. Why say it? There is plenty of evidence for the statement.
4. Does "molecular localization" mean compartmentalization? Define "GCM virus"

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IS THERE ANY BASIS TO RECOMMEND THE USE OF PROTEIN CONTENT AS A BASE ON WHICH TO EXPRESS PHOTOSYNTHETIC RATE?

1. When photosynthetic rate is expressed on the basis of chlorophyll there are, as the author states, particular cases where the photosynthetic rate does not appear reasonable. This problem was recognized a long time ago as a troublesome point and is one of the reasons why there is no single way of expressing photosynthetic rate. The method proposed by the author is no better (more will be said later), as, without doubt, exceptions will also be found to it. Further, it is certainly widely (if not universally) accepted that photosynthetic rates of higher plant leaves are best expressed on a unit leaf area (e.g. rate of photosynthesis per dm^2 per hour). The basis for using these dimensions is that total photosynthetic production by a plant is the product of photosynthetic rate times total leaf area and the use of other dimensions is often meaningless as the author points out.

2. Tables 1, 2 and 3 have apparently already been published. Thus there is no new data here.

3. The data of Tables 4 and 5 have nothing to do with the main objective or arguments of the paper and are inappropriate. They should be deleted.

4. Table 6 is the main evidence for the objective of the paper. As presented it supports the author's claims. I cannot, however, determine the origin of the data.

In the relative photosynthetic rates as listed in Tables 1 and 2 and the protein contents as listed in Table 6 many of the values given are arithmetically wrong.

Using e.g. photosynthetic rates from Table 1 and 2 and protein contents from Table 6, the following values are calculated.

The values calculated on a protein basis are very different from those given by the author and show that the correlation of photosynthetic rate to total or soluble protein is no better than the correlation to chlorophyll content. There is thus no basis to recommend the use of protein content as a base on which to express photosynthetic rate.

If the photosynthetic rates expressed on a protein basis are new rates determined by the author (and not those in Table 1 and 2) then they certainly cannot be compared to the rates expressed on a chlorophyll basis that are found in the mentioned tables.

	Photosynthetic CO_2 fixation related to		
	Chlorophyll mg	Total protei mg	Soluble protein mg
Apple leaves healthy	100	100	100
infected	77	52	126
Vine leaves healthy	100	100	100
GGM symptoms slight	46	26	122
severe	70	6	93

5. The main result of the paper is that the author finds no single basis on which to express photosynthesis that is best for all cases. This is not new or startling as it is well known that a complex system such as photosynthesis can be limited by any one of several factors.

There is no necessity and in fact no reason to expect that the limiting factor will be the same in the cases outlined by the author.

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IS THE USE OF CHLOROPHYLL AS AN INDICATOR OF PHOTOSYNTHETIC ACTIVITY STILL VALID?

Pozsár has examined the validity of referring photosynthetic activity to the chlorophyll content of leaves. He is struck by the fact that under conditions of virus infection, which results in a decreased level of chlorophyll, the specific photosynthetic activity in terms of radioactive carbon dioxide fixed per unit chlorophyll in the leaf actually increases. He also notes that in cases where synthetic cytokinins have been applied, the intensity of carbon dioxide fixation per unit of chlorophyll is also "unreasonably" high. He, therefore, wishes to question the generally accepted practice in the literature of referring photosynthetic activity to chlorophyll.

Of course, the argument can be proved at a theoretical, as well as an experimental level. We all know that there are certain steps in carbon dioxide fixation which proceed in the dark, and that photochemical activity is only a portion of the total photosynthetic process. Why should it therefore be surprising that under conditions when overall light is not limiting to the process, that dark reactions should control the rate of CO_2 fixation? I find this obvious, and the author's experiments, in fact, show that this is the case.

The fact that the application of kinetin increases the level of soluble protein, and that this in turn increases the apparent activity of CO_2 fixation per unit chlorophyll must mean that somewhere in the soluble protein fraction is an enzyme which has to do with one of the rate limiting steps in the dark fixation steps that precede the photochemical step in photosynthesis.

It seems to me that on a gross basis the use of chlorophyll as an indicator of photosynthetic activity is still valid, but we must all realize that there are instances where it is not an absolute indicator.

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CAN THE SOLUBLE PROTEIN CONTENT OF NON-ASSIMILATING TISSUES INFLUENCE CHLOROPLAST FUNCTION IN ASSIMILATING TISSUES?

The examples — partly taken from the relevant literature, partly supported by Pozsár's own experimental data — by which Pozsár discloses the anomalies of CO_2 fixation related to the chlorophyll level justify the raising of the above question, although the examples refer to virus infected plants, that is, to extreme cases, and the metabolism of a diseased plant may be changed in many respects in the same way as it is in cytochinin treated plants.

Here are some considerations related to the question:

The carbon dioxide fixation curves of leaves poor and rich in chlorophyll, respectively, follow a saturation kinetics dependent of light intensity. With low light intensities the carbon dioxide fixation of chlorophyll-poor and chlorophyll-rich leaves is proportional with the chlorophyll content. With high light intensities carbon dioxide fixation becomes, in a certain sense, independent of light intensity, the curve will be parallel with the axis of light intensity, the independent variable. At this stage it is no longer the chlorophyll concentration but the various — partly protein bound — factors of "dark reaction" that determine the intensity of carbon dioxide fixation.

In the case of different chlorophyll concentrations a change in the direction tangent of the curve of CO_2 fixation plotted against light intensity occurs with different light intensities. Pozsár dr. studied leaves of different chlorophyll content obviously at identically high light intensities, that is, at a stage less controlled — if at all — by chlorophyll concentration. In this way Pozsár's standpoint can be accepted, nevertheless the concept of "soluble protein" is not satisfactorily defined in the paper. The method of extraction does not precisely determine the value intended to be the new basis of reference either.

If Pozsár dr. means the total soluble protein content of a plant homogenizate, which can be dispergated with 0.5 per cent NaCl, this opinion can by no means be considered correct, except perhaps in one-celled algae, where anatomical dimensions change within narrow limits, and, consequently, the quantitative proportion of the assimilation apparatus to the other parts of the cell is relatively constant. For plants with more complex leaf structures, especially for dicotyledons, where the location, age, renewal-rate, plasm content of plastid cells as well as their quantitative proportion to the epidermis, water vesicles, spongious parenchyma can be the most diversified, Pozsár's definition is not — in my opinion — adequate. The other tissue element mentioned also contain soluble proteins in their plasms, and their quantities hardly influence directly the activity of chloroplasts of discrete morphological position — ultrastructure — and definite functions. In this context the metabolic relations are so distant that correlations can hardly be thought of. However, this opinion does have "historical" precedents in the literature. In one of his papers "A new concept of photosynthesis" (1931) which opposes the "physico-chemical" approach of Blackman and other contemporary authors, Kostychev supposes that certain external factors — beside chlorophyll concentration — influence photosynthesis, by stimulating or inhibiting — if not exclusively but in an indirect way — certain not specified plasmatic activities.

The question would be much easier answered if it were clear whether the term "soluble protein" refers to the soluble proteins of chloroplasts, as is suggested by the last section of the paper (. . . with the soluble protein content of the chloroplast . . .).

The first problem is that the methodological description does not decidedly refer to the isolation of the chloroplasts, moreover the sentence on page 4 . . . "The leaf proteins were fractioned with 0.5 per cent NaCl . . ." suggests that the soluble protein fraction was isolated from the whole leaf homogenizate. Judgement is made still more difficult by the fact that the 0.5 per cent NaCl extract practically contains quantitatively the non-protein nitrogen (free amino acids) fraction too, the quantity of which may be in certain cases more than half of the total amount of extracted nitrogen.

The 0.5 per cent NaCl has a hypotonic effect on the plastids as it is of a much lower concentration than the izotonic 0.35 M = 2.07 per cent NaCl. In this solution the plastids open and the protein comes out of the double layer of thylakoid membrances. Thus, if the term "soluble protein" refers to the protein of the plastids only, the suggestion is clear, as it means the functional part of the assimilation apparatus for basis of reference.

In their paper "Fraction I Protein" (Annual Review of Plant Physiology vol. 21. 1970. pp. 325—358) Kawashima and Wildman point out that e.g. from a spinach leaf homogenizate a high molecular weight protein fraction can be isolated which — after ultracentrifugated and electroforetically treated — can be considered homogeneous; this protein fraction is about 50 percent of the total amount of leaf protein and can be isolated from leaves of the most diversified species. According to **Wisselbach** (1956) this is the enzyme-like protein that catalyses PGA (3-phoshorus-glyceric acid) formation from carbon dioxide and RuDP (d-ribulose 1-5-diphosphate). A protein of this type — and, in my opinion, Pozsár's "soluble protein" is identical with it — is really a factor which can determine the intensity of carbon dioxide fixation and, in this sense, may serve as basis of reference to carbon dioxide fixation.

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IS STATISTICAL EVALUATION NOT NECESSARY?

It is quite possible that the author is right in his conclusions and his new approach could bring valuable results. Nevertheless, in my opinion, it would not be logical enough to present his paper in the form I received it. The figures given in Table 5 clearly show an exponential function, not a linear one. In my opinion, to prove the conclusions, the results should be given either with standard errors or they should be evaluated statistically.

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DOES CLOSE CORRELATION MEAN AN ORDER OF SUCCESSION?

By experiments on $C^{14}O_2$ uptake the author points out that increase and decrease induced by external conditions (diseases, cytokinin treatment) in photosynthesis seem to show a much closer correlation with the NaCl-soluble protein content of chloroplasts than eitheir with any other protein fractions or with the changes of chlorophyll content. The author draws the conclusion that the increasing and decreasing effect exerted on photosynthesis is caused by these soluble proteins.

The problem raised is interesting, the technique applied is up-to-date; nevertheless it would be desirable to clarify several points in the paper.

It is not clear, how the author applies the Kjeldahl procedure to the NH_4OH-soluble fraction.

He refers to correlations several times but does not give the coefficients. Thus the reader is compelled to determine the extent of correlation by a rough estimate. It would have been desirable to complement Table 6 by columns containing the coefficients of correlations compared.

Close correlation does not mean an order of succession at the same time (cause and effect), though in the present case the determinative role of soluble protein seems obvious. The author's standpoint would be more suggestive if in the 6–8 hour experiment, similarly to Fig 5 he measured the trends of soluble protein and photosynthesis every hour. If throughout the whole experiment the correlation coefficient remained on the same level or, on the other hand, development in one quantity lagged behind that of the other, the conclusions would obviously be different.

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WHICH FORM OF PROTEIN?

1. The sketch is too long and confused. An understandable arrangement should have been used in the introduction, material and method, results and discussions, etc. Within the chapter "Results", sub-titles should have been applied. It would have resulted in a better and clear presentation of the results. Also he should have found more suitable phrases.

2. As for the subject matter I should like to note that the base of comparison for chlorophyll or protein is well known by all colleagues. Inspite of this it would be desirable if Mr. Pozsár, just on the bases of pathologically changed tissues, investigated once again the discrepancy of the examination methods, especially if this investigation were performed in a more strict and clear form. First of all it should have been explained, which form of protein was concerned. The protein of chloroplast has been dealt with in the text. I could only gather from the methode that the protein fractions of all cells are in question.

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SHOULD THE INTENSITY OF PHOTOSYNTHETIC CARBON DIOXIDE FIXATION BE RELATED TO THE CHLOROPHYLL CONTENT?

Dr. Pozsár makes a noteworthy statement on an important subject. I assume there is no need to support the importance of photosynthetic carbon dioxide fixation. The author's observation, namely that the intensity of this process is related to the soluble protein content of the leaves seems worth noting on the grounds as follows.

The chlorophyll content is frequently used — without any special consideration — as a basis of the calculation of the intensity of the photosynthetic carbon dioxide fixation. Nevertheless the process itself is a carboxylatory enzyme reaction, which does not even require energy input. Due to their role in the light energy converting reactions, the chlorophylls certainly take some part in the synthesis of the acceptor of CO_2 (phosphorylation of ribulose phosphate) and in the further conversion of the product of the fixation (reduction of phosphoglyceric acid) but it is unreasonable to speak about their photochemical activity in this process.

One can find data in the literature that the rate-limiting step of the photosynthetic carbon dioxide fixation would be the carboxylatory reaction. If other circumstances do not inhibit the activity of ribulose diphosphate carboxylase, which is the enzyme governing the carboxylation, the amount of the enzyme is the limit to the intensity of the process. Taking into account Fraction I protein as the major fraction of the soluble proteins of the leaves (and it has only RuDP carboxylase activity) we arrive at the author's final conclusion.

In my opinion the statements are correct and we must consider both of them: 1. the intensity of the photosynthetic carbon dioxide fixation should not be calculated to the chlorophyll content and 2. the soluble protein content of the leaves seems to be acceptable for this purpose.

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IS THE LEVEL OF SOLUBLE PROTEIN DEPENDENT ON THE RATE OF CO_2 FIXATION?

Early experiments of Willstätter—Stoll (1918) showed clearly that the rate of photosynthesis in leaves is not related to chlorophyll content unless the chlorophyll content is reduced to a small fraction of its normal level. Experiments by Bidwell and co-workers (Turner—Bidwell 1965; Bidwell—Turner 1966; Bidwell—Turner-Levin—Tamás 1969) showed that sudden, dramatic changes in the rate of CO_2 fixation of leaves caused by the application of auxin were due to increased efficiency of the dark reactions (Calvin cycle and associated reactions), not to increased efficiency of light-trapping. These responses were so rapid as to preclude any possibility that a change in chlorophyll content could have affected CO_2-fixation rates. Short-term increases in the rate of photosynthesis resulting from the application of physical shock have been noted by Russian workers (Belikov 1960; Goncharick 1962), and similar increases following infection of leaves by rust fungus have been observed (Livne 1964). All these observations clearly support the conclusion reached by Pozsár (1971) that under normal conditions the rate of photosynthesis in leaves is not in anyway related to the chlorophyll content. Thus the concept of "specific activity" of chlorophyll in photosynthesis is meaningless and should be dropped from use. The likelihood that under normal circumstances the "photochemical efficiency" of chlorophyll is in any way related to actual rates of CO_2 fixation appears very remote.

Pozsár (1971) has suggested that the content of soluble proteins in a leaf provides a useful index or base-line upon which to express rates of CO_2 fixation. It is evident that protein metabolism is a major function of chloroplasts and an important aspect of photosynthesis (Hellebust—Bidwell 1963a, 1963b, 1964a, 1964b). Recent experiments in the author's laboratory show that soluble proteins are among the earliest products of photosynthesis in chloroplasts (Table 1).

The question can thus be raised: Is the level of soluble protein dependent on the rate of CO_2 fixation, rather than, as Pozsár has suggested, the rate of CO_2 fixation being dependent on the level of soluble protein? It seems likely that many of the enzymes of CO_2 fixation are parts of complexes, and as such may normally have a rather closely fixed ratio to structural components of the chloroplast (including insoluble protein). The data in Table 1 show that

Table 1

Products of photosynthesis located in chloroplasts of wheat leaves

(Leaves were supplied $^{14}CO_2$ for 30 min., then frozen in liquid nitrogen. The frozen leaves were freeze-dried, then treated in a Virtis homogenizer in a carbon tetrachloride-hexane mixture. Chloroplasts were isolated by centrifugation on a density gradient of carbon tetrachloride-hexane mixtures, and assayed. They were then suspended in aqueous sucrose buffer, immediately collected by centrifugation and re-assayed. The washing process was repeated)

Radioactive fraction	Non-aqueous chloroplasts	Chloroplasts washed once with aqueous buffer	Chloroplasts washed twice with aqueous buffer
	c/m/mg non-aqueous chloroplasts		
Sugars	8700	7200	1300
Phosphorylated intermediates	6900	6300	1800
Free amino acids	1300	900	200
Proteins	3400	700	200

photosynthetically produced proteins are not only very soluble, but so easily removed by washing that it appears unlikely that they are enzymic in nature, or connected with the process of CO_2 fixation. Furthermore, while kinins certainly cause an increase in protein synthesis, it is probable that this increase is the result of increased CO_2 fixation, not its cause. WARING *et al.* (1968) have shown that kinins, like auxins, stimulate photosynthesis.

Thus I believe that the question of interdependence of CO_2 fixation and soluble protein is still open, and cannot yet be answered on the basis of our present knowledge. The normal rates of photosynthesis are probably under some sort of energy-charge control (for example see BASSHAM—KIRK 1968, HORIO *et al.* 1968).

The concept that is likely to be most valuable to agricultural scientists is "the maximum attainable rate of CO_2 fixation". This may well be expressed on the basis of the area of ground surface occupied; that is the ultimate measure of productivity.

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DO SOLUBLE PROTEINS GIVE A TRUE PICTURE OF THE INTENSITY OF CARBON DIOXIDE FIXATION AFTER A PHOTOSYNTHETIC ACTIVITY OF LONGER DURATION?

The author's paper suggests that the intensity of photosynthetic carbon dioxide fixation should be related to the protein-, or even more so to the soluble protein unit of the plant organ or organism rather than to the amount of chlorophyll. He supports his suggestion with an observation of his, namely, that on the one hand even with an extremely low chlorophyll content — frequently occurring as a result of virus infection — increase in the protein content may be considerable, sometimes greater than that in the control; and that on the other, under the influence of cytokinin treatment even with a slight increase in the chlorophyll level the intensity of carbon dioxide fixation is high. Quantitative changes in the chlorophyll content are not proportional with the intensity of carbon dioxide fixation, therefore the latter cannot reliably be characterized by them. The author's suggestion is worth noting; nevertheless, as in every experimental work the results confirm the theory, here also, only the experimental results can decide the question. The author has arrived at the above conclusion by using the material of his earlier experiments and revising his theories based on them. The data presented in his paper support his suggestion that photosynthetic carbon dioxide fixation should be related to the soluble proteins. His results show, further, that it is soluble protein rather than total- or skeleton proteins that display the highest reactivity to actions inducing photosynthesis. The author's paper also contains a discussion about the causal relation between the quantitative changes of chlorophyll content and those of protein content. However, we should like to know the author's opinion as to whether these physiological processes only take place with this type of action mechanism under induced conditions (e.g. virus infection, cytokinin treatment), or whether natural photosynthetic carbon dioxide fixation has the same mechanism. Furthermore, whether the soluble proteins also give a true picture of the intensity of carbon dioxide fixation after a photosynthetic activity of longer duration. Namely, these facts influence the correctness of the theory on one hand, and its general validity on the other, which is not a negligible aspect.

The author's suggestion — as confirmed by his experiments — is worth being published and discussed.

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IS IT JUSTIFIED TO RELATE THE PHOTOSYNTHETIC ACTIVITY TO THE SOLUBLE PROTEINS?

In his paper B. I. Pozsár raises an important question. The extent of photosynthetic activity is highly influenced by the amount of the soluble protein fraction according to my own experiments as well. It seems probable, however, that in the same way as chlorophyll concentration in itself does not characterize the photosynthetic activity, the amount of soluble protein fraction can only characterize it in special cases.

When working under conditions very different from those of the author I experienced that the protein fraction had an influence on the photosynthetic activity. In a plant homogenisate, photosynthetic carbohydrate formation from the intermediers was measured (with the assumption that under the influence of long duration intensive illumination a gradual building up of carbohydrates also takes place beside the Calvin cycle). When homogenization is carried out with the same plant, under the same conditions but with a several days' difference, the values cannot be reproduced even with the substrate adjusted to the same chlorophyll concentration. The phenomenon is supposed to be caused by the different amounts of enzymes (proteins). When applying enzyme inhibitors we obtained a well measurable photosynthetic effect with formaldehyde substrate in the case when the reason for not observing any photosynthetic activity without inhibitors was the high extent of carbohydrate formation even in the dark. On the other hand, when photosynthetic activity could be observed even without an inhibitor, then the same amount of inhibitor as in the former case inhibited any change in the carbohydrates either in light or in the dark. This is shown by Table 1. In this case the amount of enzymes (proteins) was supposedly less compared to the chlorophyll.

In a subsequent experiment a part of the same plant homogenisate was used directly (Table 2. A). The rest was washed twice, that is, most of its soluble proteins were removed. One half was directly used (Table 2. B), the other half was added cysteine in such quantities (Table 2. C) as to make its — SH — residue content identical with that of the unwashed homogenisate. In all experiments mentioned 0.04 μmol/ml chlorophyll concentration and an amount of 10^{-4} g/ml carbon content of the intermediers were used uniformly.

As it can be seen from the data of Table 2 the removal of the soluble proteins reduced the extent of photosynthetic activity very much, especially in the case of intermediers with lower carbon atomic numbers. On the other hand, cysteine which plays the single role of an enzyme activator shows an effect similar to that of the proteins, though it does not attain the extent of photosynthetic activity displayed by the unwashed homogenisate.

Table 1

Effect of enzyme inhibitors on the photosynthetic activity of plant homogenisates

Treatment	Photosynthetic carbohydrate increase per 10 γ chlorophyll as expressed in γ
A) Formaldehyde	0.00
Formaldehyde + $5 \cdot 10^{-5}$ M/ml $HgCl_2$	6.55
B) Formaldehyde	0.00
Formaldehyde + $25 \cdot 10^{-5}$ M/ml NaF	13.09
C) Formaldehyde	0.00
Formaldehyde + $50 \cdot 10^{-5}$ M/ml Selecton B	4.40
D) Formaldehyde	14.91
Formaldehyde + $5 \cdot 10^{-5}$ M/ml $HgCl_2$	0.00
Formaldehyde + $25 \cdot 10^{-5}$ M/ml NaF	0.00

Table 2

Effect of preliminary treatment on photosynthetic activity in plant homogenisates

Treatment	Photosynthetic carbohydrate increase per 10 γ chlorophyll as expressed in γ		
	total	hexose	pentose
A) Formaldehyde	6.08	5.24	0.84
Glycolaldehyde	4.63	4.40	0.23
Glycerinaldehyde	5.18	1.67	3.51
B) Formaldehyde	0.53	0.49	0.04
Glycolaldehyde	1.25	0.89	0.36
Glycerinaldehyde	4.60	2.40	2.20
C) Formaldehyde	3.01	2.70	0.31
Glycolaldehyde	5.01	3.32	1.69
Glycerinaldehyde	5.71	1.92	3.79

The above confirms the fact that chlorophyll concentration in itself does not determine the extent of photosynthetic activity. On the other hand, the phenomenon of cysteine used as enzyme activator partly replacing the proteins (salt soluble) removed makes it questionable whether it is justified to relate the photosynthetic activity to the soluble proteins.

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IS THERE A CORRELATION BETWEEN THE PROTEIN CONTENT AND PHOTOSYNTHETIC ACTIVITY OF LEAVES OF BOTH ILL AND HEALTHY PLANTS?

Experimental material dealt with in B. I. Pozsár's article "The determination of the effect of soluble protein level on the intensity of photosynthetic carbon dioxide fixation" is of great interest. The problem of the interaction between the soluble protein content of leaves and photosynthetic activity has drawn the researchers' attention. Therefore it has been established that such interaction is postulated by the presence of a basic ferment for the photosynthetic cycle, carbon-carboxy-dismutase, in the soluble protein fraction (fraction 1).

There was a correlation determined between the soluble protein content of leaves and the level of their photosynthetic activity under increasing light intensity, in the illuminated and kept in dark clones of Solidago (Björkman 1964, 1968).

A similar effect was found in the leaves of Vicia faba as depending on the age of plants and the level of N nutrition provided (Andreeva—Avdeeva 1970).

There are, also, data representing the existence of a similar correlation in the plants, depending on their cytokinin content (Wareing—Khalifa—Treharn 1968).

Leaving out of consideration the simplified extraction method of soluble protein, the data given by Pozsár rather convincingly show that there is also a correlation between the protein content and photosynthetic activity of leaves of both ill and healthy plants.

Many of the data provided let us suppose the fact to be of common character.

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IS SOLUBLE PROTEIN A BETTER PHYSIOLOGICAL BASE THAN CHLOROPHYLL?

The hypotheses presented in this paper are poorly drawn and inadequately tested. In some cases the results are inconsistent with the conclusions. For example, from the data on virus-infected grape, it seems to be argued that soluble protein is a better physiological base than chlorophyll because P activity per unit protein declines more with advance in disease symptoms than for chlorophyll, while from the data with cytokinins on bean, it is argued to be a better base because specific activity does not change. Further, the active incorporation of glycine into soluble protein is not appropriate evidence from which to conclude that P rate is best expressed on a soluble protein basis — it simply suggests that there is a high turnover in soluble protein. The supposed "correlations" are not established statistically and since only relative P data are presented, they cannot be established qualitatively from an examination of the data.

Interpretation of the results is made even more difficult by the absence of any reference to how the plant material was grown (is it from the field, under competition, or from a glasshouse; grown in high or low light?) and on how photosynthesis was measured (high or low light; stirred chanber; normal CO_2 levels?).

Finally, the basic purpose of this research, to compare chlorophyll and protein as physiological bases seems questionable to me. Each has merits in particular situations, but more in specialized physiological studies than in field work where it is essential that leaf area be used as the basic reference.

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ARE THE CHANGES CAUSED BY VIRUS INFECTIONS OR EXPERIMENTAL TREATMENTS IN THE PHOTOSYNTHETIC ACTIVITY CONNECTED WITH MOLECULAR AND ULTRASTRUCTURAL CHANGES?

The chloroplast is known to have a very peculiar structure on light microscopic, electron microscopic and molecular levels equally. It is also more and more obvious that the special activity of this cell organ: carbon assimilation in addition to the presence of the necessary chemical components — first of all pigments and adequate enzymes — also requires their peculiar molecular and ultrastructural organization. The author supports the above statement with carefully performed biochemical experiments from a functional aspect, in more than one respects. His results obtained with virus infected plants and cytokinin treated substances, which unequivocally show that chlorophyll level *per se* has no unambiguous correlation with the photosynthetic activity, are especially remarkable from this point of view. In our opinion the author is right to explain this finding of his by the fact that the photochemical activity of the chlorophylls depends on their molecular organization too. In this molecular organisation the structure of the Lipoproteid membranes of thylokoids and occasional close connection between thylokoid membranes respectively, plays an important role. We must admit, however, that we have only hypotheses about the molecular structure of these membranes as well as about the existence of quantasomes. It is highly probable, however, that the orientation of the pigment molecules is especially influenced by the here and there close attachment of the thylakoid membranes, i.e. the granulous structure, which, in turn, may affect the photochemical activity. Thus we are justified in supposing that changes caused by virus infections or experimental treatments in the photosynthetic activity are connected with molecular and ultrastructural changes as well.

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WHAT CAN BE THE BEST BASIS TO USE IN COMPARING RATES OF LIGHT-SATURATED PHOTOSYNTHESIS?

In this paper, Dr. Pozsár considers the important question of what basis should be used for comparison of photosynthetic rates. Chlorophyll-a or total chlorophyll is often used. However, as Dr. Pozsár points out, a change in the chlorophyll content of plant tissue without a similar change in other components of the photosynthetic mechanism can result in misleading interpretations. For example, a decrease in chlorophyll content not accompanied by a similar decrease in the factor limiting the light-saturated rate can cause an increase in the saturated rate of photosynthesis per unit chlorophyll which is not a real stimulation of photosynthesis. The rate per unit plant biomass, on which the growth rate depends, may be unchanged or even decreased. Dr. Pozsár suggests that total protein or soluble protein may be a better basis for expressing photosynthetic rates. While this is a good suggestion, I believe that photosynthetic rates on the basis of both chlorophyll or total photosynthetic pigments (especially in the case of algae, with their diverse pigment composition) and one or more parameters of biomass (dry weight, cell volume, protein, etc.) should be considered during the interpretation of results. Rates expressed on both bases have a meaning, depending on the light intensity used.

At intensities below saturation the rate of photosynthesis is limited by the rate of light capture, which in turn is dependent chiefly on the intensity and spectral distribution of the light and the concentration and types of photosynthetic pigments. For a given subsaturating intensity, spectral distribution, and assemblage of pigments, one might expect the rate of photosynthesis per unit of total photosynthetic pigments to be approximately constant. Below saturation, then, rate of photosynthesis per unit chlorophyll or per unit photosynthetic pigments may be the most meaningful expression. At intensities above saturation, the rate of photosynthesis is limited by some dark reaction. At these intensities no constant relationship of photosynthetic rate to chlorophyll should be expected when the chlorophyll content of the tissue varies. Rather, one might expect a constant relationship between the rate of photosynthesis and the concentration of the rate-limiting enzyme or cofactor. The difficulty of measuring the latter will probably prevent it from being used routinely. However, soluble protein or total or soluble chloroplast protein may well serve as a useful substitute. The rather constant relationship between photosynthesis (presumably light-saturated) and soluble protein in bean leaves treated with artificial hormones shown in Table 6 of Dr. Pozsar's paper suggests that this may be so. Some protein component may be the best basis to use in comparing rates of light-saturated photosynthesis.

Photosynthetic rates are often used to estimate growth rates, and this is perhaps the ultimate interpretation whether one is concerned with the growth of agricultural crops or the production of phytoplankton. In order for photosynthetic rates to be most useful for this purpose, they should be expressed in such a way that they best approximate growth rates. This means choosing some basis which bears a more constant relationship to plant biomass than either chlorophyll or some protein component. This could be any of dry weight, tissue area or volume, or organic carbon. Perhaps organic carbon is the best choice for this purpose since it allows calculation of rate of carbon, which can be converted directly to doubling times. This procedure is readily applicable to plants which are largely composed of photosynthetic tissue, such as most algae, and perhaps could be adapted for use with higher plants.

There are many parameters to which photosynthetic rates could be related. The choice of which to use depends on the question the experimenter is asking. In order to increase the usefulness of one's data, one would do well to consider presenting rates per unit pigment, per unit protein, and per unit biomass (dry weight, organic carbon) or at least include conversion factors for the plant tissue being used, so the reader can convert the rates given to another basis. When photosynthetic rates as a function of light intensity are measured, plotting rates on the basis of two or three parameters may be helpful in interpreting what changes are occurring from one plant treatment to another. The results of Steemann Nielsen *et al.* (1962) illustrate this for the relatively simple situation of a unicellular alga grown under high and low light intensities. A more thorough consideration of rates of photosynthesis above and below saturation expressed on the basis of several parameters, including protein, may be useful in understanding the more complex situation of higher plants infected with disease or treated with hormones.

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DOES THE AMOUNT OF SOLUBLE PROTEINS IN THE PLASTIDS OR PLASM DEPEND ON THE PHOTOSYNTHETIC CO$_2$ FIXATION?

There are various bases of comparison known — e.g. the levels of chlorophyll and protein — that the intensity of photosynthetic carbon dioxide fixation can be related to. On the basis of data presented in the paper certain correlation between the intensity of photosynthetic carbon dioxide fixation and the level of soluble proteins seems obvious, therefore the latter can be readily used as the basis of correlation.

As to the suggestion that the level of soluble proteins in the plastids — except for those with extremely high and extremely low chlorophyll contents — can be used as a base of comparison when determining the intensity of photosynthetic carbon dioxide fixation I agree with the author. However, I should like to make some remarks on the paper.

1. There is no exact indication in the paper as to whether the amount of soluble proteins was determined from isolated plastids or from the whole leaf. Considering that the data of the tables refer to fresh weight, determination must have been performed with whole leaves used. Thus the data show the soluble protein level of the leaves rather than that of the plastids, because the extracts mostly contain the soluble proteins of the plasm. Unfortunately, this conclusion that the level of soluble proteins in the plastids correlates with the intensity of photosynthetic carbon dioxide fixation cannot be drawn from these data. In order to confirm the author's hypothesis concerning the correlations between soluble proteins and photosynthetic carbon dioxide fixation, direct determination of the level of soluble proteins in the plastids would be necessary.

2. In the course of chlorophyll synthesis or degradation the stability of different forms of chlorophyll complexes vary. In the greening process chlorophyll-a protein complexes are synthetized the most rapidly, while in the case of senescence these forms appear to be the most stable. This phenomenon might explain the high biological activity in cases when the total chlorophyll level in the leaves is relatively low. In the case of a higher total chlorophyll level a relatively lower, while a lower level a higher proportion of chlorophyll is presumably in active form. Thus, a relation to the total chlorophyll content can by no means express the actual situation.

3. Inasmuch as the level of soluble proteins in the leaves is determined, the base of comparison suggested by the author can be used only in cases when the factor examined has a low stimulating effect on the general protein synthesis.

4. No doubt, the kinetin-like substances (kinetin, benzyladenine) raised the protein level of the leaves, and simultaneously on increase in the intensity of photosynthetic carbon dioxide fixation could also be soon detected in the situation presented. This fact is clearly shown by the data of the tables. It has also been unambiguously demonstrated that these kinetin-like substances raise the level of soluble proteins in the leaves. The inhibiting effect of kinetin on chlorophyll degradation is also well known. This effect can generally be attributed to its stimulating influence on the protein synthesis. On the other hand, the existing antagonism between the kinetin and certain amino acids in this respect suggests that kinetin stabilizes the chlorophyll content and through this the biological activity of plastids primarily by preventing or inhibiting the protein decomposition (SCHIBACKA–THIMANN 1970).

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IS REDUCED PHOTOSYNTHETIC ACTIVITY THE EFFECT OF LOWERED PHOTOCHEMICAL ACTIVITY?

The paper by B. I. Pozsár entitled "The determination of the effect of soluble protein level on the intensity of photosynthetic carbon dioxide fixation" provides some interesting data on the manner in which pathogens can reduce photosynthesis and how this can be restored by synthetic cytokinins. Although infection undoubtedly reduced photosynthetic activity, it is not certain, on the basis of the data provided, that this reduction was due to lowered photochemical activity. Especially interesting was the restoration in photosynthesis, following the application of the cytokinin, which was not attributable simply to increased chlorophyll content. The increase in soluble protein, and presumably photosynthetic enzymes in the chloroplasts, is, as the author suggests, the most likely explanation. Further experimentation would be required to establish, biochemically, how the cytokinin has asserted its effect.

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IS THE INCREASE IN THE INTENSITY OF PHOTOSYNTHETIC CARBON DIOXIDE IN POSITIVE CORRELATION WITH THE FUNCTION OF THE QUANTOSOMES?

The author tried to prove the functional relationship between photosynthetic carbon dioxide fixation and protein fractions directly by experimental data. This circumstance was made especially striking with the synthetic cytokinins applied (kinetin, benzyladenine) when the intensity of radiocarbon labelled carbon dioxide fixation was proportional with the increase of the soluble protein fraction. It seems to be thus confirmed that any increase in the intensity of photosynthetic carbon dioxide fixation which can be induced by cytokinin treatment is in positive correlation with the function of the quantosomes.

In biochemical examinations the intensity of photosynthetic carbon dioxide fixation has been related to mg chlorophyll, so the author's method of relating it to mg protein (mg soluble protein) which underlines more strongly the real correlations of these processes is very interesting.

In spite of the fact that the results of biochemical and radiochemical experiments are generally expressed in cpm/mg active, agent, it would — in my opinion — be much more correct to express the specific activity in absolute radioactivity (μCi/mg) which would eliminate possible differences in colour extinction effect between the samples.

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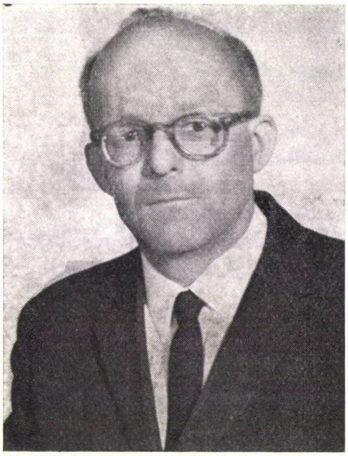
CHRONICA



BARNA GYŐRFFY

1911—1970

Barna Győrffy, director of the Institute of Genetics of the Hungarian Academy of Sciences, and former president of its Genetical Committee was born on July 18th, 1911 at Szepesbéla (Spiska Belá) at the foot of the High Tatra, in the nature-loving maternal grandfather's house which is now a part of the Tatra Museum. His father, István Győrffy, the well known hybryologist, was at first teacher of natural history and geography in the secondary school of Lőcse, then, from 1914, professor of general botany at the universities of Kolozsvár, Budapest, Szeged, and for a while in Kolozsvár again. By his father Barna Győrffy learned to like and know the beautiful though tiresome work of collecting and identifying plants, and climbing mountains in his early childhood. He became fond of the Tatra where he returned nearly every year up to the end of his life to collect material during holidays for his experiments.

He attended the elementary school in Kolozsvár, Budapest and Szeged, and secondary school in Szeged. It was also in Szeged, at the university, that he graduated in 1935 obtaining a secondary school teacher's diploma in natural history and chemistry, and in 1936 a degree of Ph. D. Then in 1943 he was awarded a degree of private docent in Kolozsvár.

His first scientific paper was published in 1932 when he was still a student. His paper "Fejlődésélettani vizsgálatok *Catharinaea Hausknechtii*-n" (Developmental biological studies on *Catharinaea Hausknechtii*) published in 1936 is already the work of a scientist familiar with the various branches of botany, namely, morphology, physiology and phytogeography. The main line of his research work was, however, determined by a longer visit to Germany between 1937 and 1939 when he worked as a scholar under Prof. F. von Wettstein at the

Kaiser-Wilhelm-Institut für Biologie of Berlin-Dahlem and became a geneticist. It was at that time that the multiplying effect of colchicin on the chromosome complement was discovered and polyploid plants produced. Barna Győrffy enthusiastically joined in this research work, and as early as in 1938 published a paper on autotetraploid plants artificially produced by colchicin treatment, and another one with G. Melchers as co-author on the fertile amphidiploid of *Hyosciamus niger* × *H. albus.*

Returning to Hungary he continued his ploidy studies at the Hungarian Biological Research Institute of Tihany; however, emphasis shifted from methodological questions to morphological, physical and biochemical studies of the doubling of the chromosome complement starting investigations on the inheritance of vitamin C content of tomato and paprika.

In 1944 he moved to Magyaróvár, where he became the head of the Biological and Genetical Laboratory of the Agricultural Research Institute and joined in the work of training plant breeders. He continued his studies on polyploidy and vitamins, furthermore, species hybridization and vernalization experiments were also started under his leadership with cereals.

In the spring of 1948 he participated in a study tour to the Scandinavian countries, and after his return was elected director of the Research Institute for Plant Genetics and Breeding in Budapest, and for three years undertook leadership at the Biological Department of the University of Agricultural Sciences as well.

In 1949 his Institute was reorganized into the Genetic Department of the Agrobiological Institute; but later in 1950 it was taken from the control of the Ministry of Agriculture and put under the authority of the Hungarian Academy of Sciences. Since 1954 it has been the Institute of Genetics of the Hungarian Academy of Sciences. As a director his first task was to finish the reconstruction of war-time damage, and to train a qualified group of research workers. Restoration, science policy, reorganization and partly, education required a great deal of administrative work, so research work temporarily slowed down and shifted to some extent to the field of plant physiology. In spite of all the difficulties his work met with recognition. In 1949 he was awarded the Kossuth Prize, in 1953 the Medal of Merits in Socialist Work; in 1952 he was qualified Candidate and in 1957 Doctor of Biological Sciences by the Hungarian Academy of Sciences.

It was due to his initiative that the first bacterium-genetical studies in Hungary, among them transformation experiments on *Rhizobia*, began in 1950 in his Institute. He studied the development of streptomycin resistance, the effect of chemical mutagenes, the sensitivity to ultraviolet radiation of pigmentous and pigmentless strains of *Serratia marcescens.* He discovered a new bacteriocin: the tabacin of *Pseudomonas tabaci.*

Beside his studies in bacterium genetics his favorite plants were not neglected. He continued the polyploidy studies, started population genetical experiments and carried out cytological and cytogenetical research. In the species of the genus *Ranunculus*, on the basis of the karyotype, he demonstrated the relation of the degree of evolution.

In the early sixties he completely returned to his plants, and recognizing the importance of evolutionary genetics propagated it through lectures, and developed a group of enthusiastic young research workers to cultivate it. He began to deal again with the subject of his university studies: the mosses; collected a rich material from various parts of Hungary, and mainly from the Tatra, maintained them as cultures in Petri-dishes, classified them, and determined the so far unknown chromosome numbers of several species. Recently in the species *Funaria hygrometrica* and *Physcomitrium pyriforme* he produced polyploids from the seta by gametophyton regeneration and started isozyme examinations.

Meanwhile he visited many biological institutes and research places and attended international sympozia in the German Democratic Republic, the Soviet Union, Poland, England, the German Federal Republic, Roumania, Czechoslovakia, Austria, Japan, the United States of America and Canada; he delivered lectures at a number of international congresses, and organized an international symposium. During his journeys abroad he made the work and results of his Institute known, gathered experiences and utilized them in improving genetical research in Hungary.

He was extremely versatile. He was interested in the entire field of biology and familiar with almost every aspect of genetics. He performed his experiments with plants and partly with bacteria, but apart from this directed genetical research on animals and delivered lectures in the field of human genetics as well. He was familiar with the genetic implications of animal and plant breeding too. Tobacco breeding was also carried on under his leadership. Upon the request of plant breeders and foresters he presented lectures on the recent advancement of genetics, maintained close contact and friendly relations with his pupils; every breeder and technician could learn the methods applied in his Institute.

Barna Győrffy paid much attention to scientific training. In his Institute he developed a group of enthusiastic young research workers, and irrespective of their posts assisted young people who wished to continue their studies. He organized extension courses within, and scientific lectures at every level outside the Institute.

His scientific papers (over 75), the innumerable lectures delivered by him, and his directing, teaching and organizing activities made him highly esteemed and recognized both in Hungary and abroad.

Unfortunately, the line of his research with the results collected so diligently and cautiously was abruptly broken. The building he had been planning had received a solid foundation and the walls were almost finished but he did not have a chance to put on the roof. Returning from the XIth International Botanical Congress in Seattle and the connected lecture tour in USA and Canada, he felt inspired with new ideas but unusually tired. Ignoring his weakness he indeepened in hard work. His last lecture was on March 10th, 1970, at the ceremonial opening Meeting of the Section of Agrogenetics and Breeding of the Hungarian Agricultural Society. Owing to his illness he refused to accept the presidency of this Section, so kindly offered. Three days later the medical treatment could no longer be delayed, but even in hospital he continued his work, kept up with the current literature and the actual results of his coworkers, wrote letters, gave instructions, visited his Institute and his experiments when his doctors would allow it.

He died August 5th, 1970 after long suffering borne in silence with his strong will. The funeral was given by the Hungarian Academy of Sciences.

L. DANIEL

RECENSIONES

S. Kapás: *Magyar növénynemesítés.* (Plant breeding in Hungary). Akadémiai Kiadó, Budapest, 1969.

Plant breeding has a history of about hundred years in Hungary. Though there are records of many earlier initiations, these cannot be considered as deliberate plant breeding work. The book was published on this occasion and meant to be a review of the activity and results of the hundred-year- old Hungarian plant breeding.

The editor and authors of the book intended to present the results and past events of Hungarian plant breeding as placed in the framework of universal plant breeding. Unfortunately, the framework has been made too large, thus publications about Hungarian plant breeding are only appendices of the history and development of plant breeding in the world. Parts actually discussing Hungarian plant breeding occupy but one-third of the volume. Thus the title of the book does not precisely conform to the content, it suggests more about Hungarian plant breeding than it really gives. All these, naturally, do not mean that even three times as much could not be written on plant breeding in Hungary, since it has a very rich and successful past which deserves appreciation all over the world.

Besides the editor the book has 12 authors. The total extension is 758 pages including 7 pages of front page and contents, 35 pages of references (about 1100 items) and 28 pages of index. Thus the text of the work amounts to 688 pages.

Authors' book is the second work written on Hungarian plant breeding. The first one was published about half a century ago by Fabriczius (1921) and treated the cca. 60 years old history of Hungarian plant breeding. However, that period was less important than the subsequent decades when plant breeding occupied its reasonably dominant place in Hungarian agriculture. Authors' work has the great merit of being the first to give a comprehensive review of the full scope of plant breeding. Thus, agricultural and horticultural plant breeding (including vine) is discussed in detail, only the questions of forestry- and medicinal plant breeding are omitted, but their importance has reached anyway a lower level in Hungary.

Apart from the introduction the book is divided into two main parts: a general and a detailed treatment of plant breeding. The introduction and the general part are of shorter extension (consist of about 100 pages), the rest was reserved for discussing the plant breeding questions of the individual plants. The introduction deals with the importance of plant growing and plant breeding in social development. It surveys the major historical changes from the ancient times to our days.

The first chapter of the general part describes the geographical position and ecological conditions of Hungary, pointing out that about 83 per cent of the area of the country located between 45°50' and 48°20' of north latitude and 16° and 25° of east longitude is at a height of 0—200 m above sea level. The peculiar climate of the country requires additional efforts from plant breeders.

The second chapter of the general part gives information — though of general character only — on the development of plant breeding theories and methods, while the third chapter is about the history of plant breeding. In the latter chapter a separate part deals already with the historical aspects of Hungarian plant breeding, discussing especially the events and results of Hungarian plant breeding before the first world war, between the two world wars and after the second world war.

The fourth chapter of the general part deals with the importance of plant varieties in production, with special regard to the development and system of variety qualification. It is a pity that among the names written below the pictures of the first registration committee Gyárfás József stands for Legány Ödön by mistake. Namely, the most eminent Hungarian plant breeders: Emil Grábner, Elemér Székács, Ödön Legány, Rudolf Fleischmann and László Baross took part in the first registration committee.

The detailed description of plants occupies a considerable part of the book. Here breeding problems of agricultural plants, vegetables, fruit bearing plants and vine are separately dealt with. The description is extended to 78 species and groups of varieties respectively, and sums up the breeding of Gramineae in Hungary. The following questions are dealt with concerning the individual species and variety groups: taxonomical aspects, questions of origin, production data, history and results of general and Hungarian breeding of the species, presentation of improved varieties and objectives of breeding work. These chapters give detailed information on the biology of species and groups of varieties respectively as well as on the methods of breeding.

The species are not elaborated according to the same pattern, which also reflects the different viewpoints of the authors. These differences are due to the different economic importance of species in the varied programme of Hungarian plant growing. That is why major crops are dealt with in some detail, while less important species only touched upon.

Authors have succeeded in giving a rather full picture of the progress and results of plant breeding including Hungarian plant breeding. It would have been better if we could get acquainted with the biographical data of the important Hungarian breeders more fully, however, necessary factual data on them can be found — though distributed (among the detailed data) — by the reader.

GY. MÁNDY

Züchtung und Anbau von Feldfutterpflanzen. (Wissentschaftliche Vortragstagung des Instituts für Pflanzenzüchtung Bernburg der Deutschen Akademie der Landwirtschaftswissenschaften zu Berlin am 1. und 2. Dezember 1966 in Bernburg.) Deutsche Demokratische Republik, Deutsche Akademie der Landwirtschaftswissenschaften zu Berlin, Berlin 1967, 1–282.

The book summarizes on 282 pages the lectures delivered at the scientific session held on the 1st and 2nd December 1966 at the Bernburg Institute for Plant Breeding of the Academy of Agricultural Sciences in the German Democratic Republic. The papers written in German of the lectures delivered are followed by German, Russian and English summaries, generally a list of references, and finally the address of the lecturers. The preface and the postscript of the book were written by Hg. Steikhardt, director of the Bernburg Institute for Plant Breeding.

During the two days' scientific conference the participants discussed several problems of cultural practices, seed production and breeding of forage plants. Development in these branches is urged, and practical use of results ensured by the national economic programmes aimed at providing the population of the German Democratic Republic with abundant and diversified supplies of animal products. These objectives — as Hg. Steikhardt said in his opening statement — can only be achieved by an increased crude protein and starch value production to be provided by the field crops. Intensive research in this field of agricultural sciences has been carried on for a relatively short time in the German Democratic Republic. The organizers of the conference in Bernburg set the aim of assessing the results of these researches and drawing up the main lines of future action.

During the two days 23 lectures were delivered on cultural practices, two lectures dealt with the problems of seed production while further five with research work on forage plant breeding. In addition to the Bernburg Institute the lectures represented 13 other institutes, universities, colleges, etc. of the German Democratic Republic.

The lectures gave account of researches carried on in a wide range of subjects related with nearly all species of forage plants. It is therefore not possible to give a comprehensive summary, even any sort of grouping is very difficult.

In the scope of subjects related to cultural practices 5 lectures dealt with the problems of nutrient supply to various forage plants. It was worth nothing that only one lecturer, D. Eich discussed the fertilization and irrigation problems of mixtures of perennial papilionaceae and grasses. These plants are of great importance even now, and — as the lecturer pointed out — a further increase in the N-doses makes it possible to use the hay as low-grade flour or fodder, which, however, raises another problem, namely, whether under certain conditions the increase of N doses becomes toxic or not. G. Specht's lecture who in his experiments with forage rye, green forage maize and silage maize studied the marginal N-doses both from crop production and economic points of view was remarkable. The methodological aspects of experimentation and evaluation were also valuable in the lecture. Out of three lectures dealing with the subject of nutrient supply two discussed the N-fertilization problems of forage rye, while the third—by G. Kratzsch—those in the Beta sp. (for forage purposes). According to the results of experiments the optimum N-dosage was 220 kg/ha to sugar-beets and 160—180 kg/ha to forage beets depending on the site of the experiment. The various types of beets are suitable for feeding purposes according to their genetically determined leaf forming capacity. Returning to the lectures on experiments with forage rye, W. Schweiger carried on N-fertilization and sowing-time experiments and determined the optimum quantities of N applied as well as the compensing effect of N-doses on the crude protein production of winter crops sown late. O. Krause studied the effect of winter manuring on forage rye stands. His results confirmed the effect of the well-known mulch forming substances on the moisture content, temperature and structure of the soil, and finally, the effect of farmyard manure on the increase of productivity in forage rye.

Another area of research was dealt with by H. Patzold who studied the utilization of genetically established productivity in forage plants. He pointed out that the utilization of genetically established productivity can practically be considered relatively good in the Trifolium sp., but deficient in the Gramineae. The reason for the latter is mostly the insufficient utilization of the growth rhythm, which — of course — is not even possible with clovers owing to the different growth rhythms of the components. The lecturer provided a valuable contribution to the solution of the problem both for breeders and plant growers.

Feed crop requirements of farms with different natural conditions can be met only by growing species best fitted to the given conditions. E. Buhtz' series of experiments gives help in this problem; he tried to find the most productive species among the perennial papilionaceae, grass mixtures and annual forage plants available in four growing sites with different soil types and yearly amounts of precipitation. In Central Germany it is lucerne and red clover that produce the highest yields among the perennial forage plants. Among the annual plants sugar-beets and fodder beets showed the highest productivity, while in light soils the green maize mixture produced the greatest amount of dry matter — 119.6 q/ha.

In the next lecture V. Ehrenpfordt discussed the interesting current problem of hay producing farms: the compatibility relations of legumes. In this scope of subjects — as it is known — the occurrence of various pests and diseases is the greatest problem. The lecturer studied the productivity of 11 plant species in alternating and monocultural production. Compatibility relations are less dependent on the soil and climate than on the species. The wrong succession of papilionaceae, and even more the monoculture may often cause 30–50 per cent or more decrease in yield.

Efforts made by the German research workers to make practical use of the possible advantages of irrigated field production of forage plants are quite justified. This effort is reflected by W. Breunig's lecture who studied seven grass- and four clover species in his irrigation experiments. By varying the amount of irrigation water applied as well as the time of application he obtained very different yields in the different species. The 144.1 q/ha dry matter obtained in *Dactylis glomerata* L. and 28.6 q/ha crude protein production of the *Medicago varia* L. are by all means remarkable results.

The lectures delivered show that German agriculture has relatively little experience in the practical use of clover production. Ch. Meinsen studied in his experiments whether *Dactylis glomerata* L. and *Festuca pratensis* H. can be produced at all without irrigation in coastal areas. He tried to find out the optimum measure of nitrogen application, its effect on the quality of feed, and finally the possibility of increasing row distances when planting.

Three other lectures set the aim of presenting some experimental results concerning the production of lucerne, the most important forage plant of the German Democratic Republic.

R. Breternitz discussed the method of planting lucerne in light soils and also gave answer to the following two questions. 1. Should lucerne be grown in pure sowing or mixed with grasses? 2. Shall we use covering plants when planting? E. Thomas studied the effect of the environmental factors on the volume of lucerne seed production. Much use can be made of his lecture by those who undertake the extremely complicated task of lucerne seed production which requires much skill. R. Steuckardt's lecture referred to the same subject. The lecturer studied the effect of the date of harvest on the thousand-grain-weight, germinative capacity, power of germination and harvesting losses. He studied further the effect of CCC the well-known plant retardant in seed lucerne stands. In his experiment he could not demonstrate the effect of CCC either on the growth of plants or on the amount of yields.

The reader of the book meets maize, a fodder plant of increasing world importance but once, although — as the lecturer G. Batz also pointed out — the 105–117 q/ha dry matter and 75–80 q/ha starch value are remarkable quantities. Silage of high nutritive value can be ensured only with optimum spacing. The lecturer provided a good experimental material to this problem.

The next three lectures dealt with some agrotechnical, harvesting and seed production problems of forage cabbages. On the basis of experiments performed in medium- and good quality soils of the Baltic coast F. Lüddecke suggested the most favourable time of harvesting. Bässler discussed hibernation in the field of cuttings made of two-years old forage cabbages for the purpose of seed production. The expensive clamp-storage is dispensable only with varieties more winter-hardy than the present ones, which sets tasks for plant breeding. The next lecturer H. Herman also raised the most delicate question of forage cabbage seed production. However, while the former lecturer attempts to solve the problem by hibernating the cuttings in the field, the latter elaborated a new — and in the lecturer's opinion the only successful — method of clamp-storage.

In the two days consultation attention was paid to two annual papilionaceae: the Persian clover and the Alexandrian clover. Their production practice has not developed in the German Democratic Republic, and the experiments are only of informative character. No doubt, the Persian clover is a forage plant to be considered, especially under irrigated conditions, when it may even be used as a secondary crop.

The organizers of the consultation did not want to leave anything out which is proved by the fact that lectures were delivered even on species of relatively low importance. For example, G. Watzke dealt with the question of planting and some problems of rye and vetch mixtures grown on 1—1.5 percent of the total area under cultivation. M. Brummund reported on his experiments of chemical weed control over seed producing bird's foot *(Ornithopus sativus)* stands which can be taken into account in sandsoils; while H. Zimmermann on the possibilities of planting cow parsnip *(Heracleum spondylium)* — a mere curiosity for the time being — into light soils and on the economic value of this plant.

Further three lectures were delivered on plant growing subjects. R. Meitz' subject was of local significance, as it was about the possibilities of commercial production in a relatively dry district (Oderbruch) with bad water management where feeding conditions were highly problematic. In his lecture calling general attention and offering many useful conclusions W. Simon dealt with the "desiccation" problems of forage crops. The lecturer discussed not only the method of defoliation applied in seed production, but also the drying of plant stands developed from the former method; it serves the removal of the superfluous water content of plants before harvesting in order to reduce the high cost of drying. This method also increases the value of the components at the same time. Finally, in the first part of the book we find a lecture by G. Schreiber on the subject of grazing which also proves that the scientific conference dealt with many questions.

The five lectures presented in the second part "Forage plant breeding" do not belong to the same subject. Besides theoretical, genetical questions there is a report here on comparative variety tests too.

K. Bellmann's lecture describes quantitative genetical methods applied in breeding cross-pollinating forage plants. The lecturer tried to give answer to such methodological questions as heritability, degree of dominance and the estimation of genetic correlation. These parameters are important in 1. forecasting the result of selection, 2. deciding which type of selection method can be successfully applied, and 3. establishing the index of selection.

In his lecture R. Focke presented his method of breeding facultative or obligate cross-pollinating plants in the case of which the classical hybrid seed production could not be taken into account for economical reasons. In his method he makes simultaneous selections for additive genes and those of superdominant interaction, where a breeding cycle lasts for two years.

U. Schütze carried on sowing time experiments for three years with common vetch (*Vicia sativa* L.) varieties in order to find out the breeding value of the material examined. With his test material — of no large volume — he pointed out an expressed variability in dry matter production, rhythm of growth and development, reaction to day length and vernalization tendency. His experiments try to find answers to plant breeding problems, and call attention to the possibilities of combinative instead of the traditional selective breeding methods.

In his lecture W. Kappel says that the highly valuable *Sorghum vulgare* Pers. varieties and hybrids have not spread so far in the German Democratic Republic. Performance tests were carried out between 1964 and 1966 with *Sorghum* hybrids imported from Roumania in order to study the possibilities of producing this plant species .

The subject of the closing lecture delivered by F. Papenhagen was the fertility problem of the valuable tetraploid red clover species. The lecturer had studied the fertility conditions of a number of commercially produced tetraploid red clover species and in his lecture outlined the tasks to be performed by the breeders in this field.

The scientific conference covered a vast material. To write more about it would exceed the limits of a summary. We only aimed at calling attention to the problems the conference had discussed, those dealt with by the plant growing researchers of the German Demoractic Republic in their efforts made to increase the yields of their feed crop production. Experiences gained and ideas raised are of topical interest beyond the borders of the German Democratic Republic as well, and the approaches are very instructive.

From a methodological point of view both plant growers and plant breeders can find much useful material in the lectures delivered.

L. BALDASZTI

A. BÁLINT: *Protein Growth by Plant Breeding*. Akadémiai Kiadó, Budapest 1970. 172. pp., 64 figures, 81 tables.

In the preface the author mentions that although the total protein supply of the population is sufficient in Hungary, the ratio between animal- and plant origin proteins consumed is not favourable. 70 per cent of the fodder requirements are satisfied with maize; however, its protein quality is not favourable and good feed conversion can be attained only when it is supplemented with feedstuffs of higher protein content and better amino acid composition. In 1954 extensive experiments were started with a number of plant species at the Department of Plant Breeding of the University of Agricultural Sciences, Gödöllő, in order to increase the protein content and improve the amino acid composition of feed. Six research workers in five papers give an account in this book on their work and results obtained.

A. Bálint: Improvement of the chemical composition of maize kernels by breeding. Pp. 9—74. The Introduction points out that the protein deficiency in the forage of Hungary amounts to 100—120 thousand tons; and 90 per cent of this is due to protein poor fodder, mainly maize. As a result 5—6 kg feed is required for the production of 1 kg pork, and 30—40 per cent of the feed is not converted by the poultry. A 1 per cent increase of the protein content of maize would raise the total protein content of feed by 5—6 per cent.

Chapters "Review of literature" and "General remarks" discuss through 20 pages with the help of tables and figures the possibilities of protein increase of grains and improvement of amino acid composition, including the oil content.

Experiments carried out between 1954 and 1967 were aimed at producing an initial material suitable for developing maize hybrids with favourable amino acid composition and high protein content, studying its possibilities, and in this context investigating the variability of protein- and oil contents in grains.

The plant material of the trials consisted of numerous varieties and lines, varieties included in the national variety trials in 1954, variety- and double-cross hybrids, *Zea mays* × *Euchlaena (Zea) mexicana* hybrids, biochemical mutants produced with X-rays as well as of opaque-2 and floury-2 crossings. The total protein content was determined on the basis of total nitrogen × 6.25 obtained by the Kheldahl method, and digestion — in order to accelerate the process — with a mixture of H_2SO_4 and H_2O_2. Separation and quantitative determination of amino acids were carried out by means of paper chromatography, while Rf values were determined through a photodensitometric treatment of spots.

Major results: Protein- and oil contents depend to a great extent on the variety and environment; average values ranged between 10.5 and 8.4, and 3.2 and 1.3 per cent respectively with the 17 varieties of the national trial, and between 10.4 and 8.4, and 2.8 and 2.4 per cent respectively at the 17 growing sites, indicating a considerable interaction between variety and growing site. Unfortunately, there was no adequate data processing. In one of the experiments carried out at Gödöllő the average protein percentage of 35 samples including sweet corn and pop-corn ranged between 13.75 (Maiskönig) and 8.06 (Silvermine).

The protein content of certain *Zea* × *Euchlaena* hybrids even exceeds 17 per cent; however, elimination of unfavourable characteristics introduced with *Euchlaena* requires a breeding work of long duration, meanwhile the protein content decreases. A number of lines with outstanding combining ability and higher than average protein content have been developed; some of them have satisfactory oil content and amino acid composition too.

Biochemical mutants were produced by an initial material developed from a local variety and line WF9 irradiated (X-ray of 7—15 kr). Primarily from this material, but also from a material not treated with mutagenes some lines with high protein- and oil content could be selected. When breeding for protein content, a considerable difficulty is caused by the fact that high protein content is not readily coupled with good combining ability, and the protein contents of the hybrids are generally similar to those of parents with the lowest protein contents; so it seems reasonable to produce single-cross hybrids.

There was a fluctuation shown in the amino acid composition of the amino acid mutants (opaque-2, floury-2, etc.), and their good characteristics can only be maintained in the crosses by a strict selection.

L. Mészáros: The effect of the sexual mentor and crude protein content in maize. Pp. 75—87. In experiments aimed at supporting the mentor theory, in case of pollintaion carried out with a mixture of pollen obtained from P^{32} labelled sunflower and maize, the isotope from the pollens not participating in the fertilization penetrates into the embryo. Changes in the protein content as influenced by the sexual mentor are studied in three free-pollinated maize varieties, with lupine- and sunflower pollens used as mentors. Results obtained are rather dispersed and partly contradictory, so unsuitable for drawing conclusions.

G. Kotvics: Investigations on increasing the protein content of *Secale cereale*. Pp. 89—98. Flour used in Hungary for baking bread contains 25—30 per cent rye flour, it is thus important to improve its quality. With this in view the commercial variety Kisvárdai *S. cereale* was crossed with the high (22%) protein content perennial species *S. monthanum*. In the F_1 generation the protein content was close to that of the wild parent, while in the next generation it decreased; in the F_4 generation it exceeded that of the cultivated parent by 30 percent, but in the perennial forms no change parallel with the age of the plant could be observed. Amino acid composition in the hybrids was also favourable, and the biological value of the protein in certain strains exceeded that of both parents. On the basis of data obtained there seems to be a possibility for developing a rye variety superior to those cultivated.

J. Füredi: Importance of breeding peas with increased protein content. Pp. 99—128. In an experiment containing a large material of marrowfat-, sugar- and fodder pea varieties changes in the protein content of the individual parts of the pea plant during the ontogenesis were examined, and the effects of site and years on the protein content of seeds studied. Unfortunately, no statistical evaluation of the interactions is presented. There is an attempt made to assess the genetic variability of varieties. In lines isolated from the varieties Pauli and Kelvedon a genotype variability could be observed in addition to the high variability attributed to the crop year in question. By selection started in the F_2 generation of crossed populations lines with different protein contents could be developed.

The prolixity of the publication — unusual with scientific papers — together with the unnecessary citing of some authors makes understanding difficult.

D. Dudits—J. Sutka: Genetical change of characters by mutation in peas. Pp. 129—174. The aim is to study and utilize the process of mutation in breeding work. The experiment includes the variety Petit Provençal suitable for both processing and fresh consumption, and the fodder pea variety Iregi P_1. Seeds of both varieties were treated with X-rays (7 and 12 kr) and ethyl methane-sulphonate (EMS; 0.1—0.42% solution, with preliminary soaking for 15 hours and without), and the results were subjected to biometric analysis.

As a reaction to the treatments a growth- and seed-set inhibition could be observed in the M_1 generation. X-rays also increased lethality to a high degree, while EMS did not. Mutation rates determined on the basis of the M_2 generation were the highest in the material treated with EMS combined with preliminary soaking, and the lowest with X-rays applied.

Besides the chlorophyll mutants (albino, xantha, chlorina) there also occurred leaf-, stem-, pod- and seed form as well as colour mutants.

Among the quantitative characters, changes in plant height, number of nodes, time of flowering, position and appearance of pods, growth rate, number of pods, thousand-grain-weight and protein percentage are studied. Special attention is paid to the polygenic mutations; in the M_2 generation, the phenotypic variancies, with the exception of pod number, under the influence of EMS treatments, and the thousand-grain-weight under the influence of X-rays increased reliably. The analysis of changes in the stage of development deserves special attention. In the M_4 generation correlations and genotype variancies of plant height and certain yield components are also studied. As a reaction to EMS treatment correlation between the numbers of nodes and pods became less close, and the genotype variancies increased (characters studied were: plant height, number of nodes, number of pods, number of seeds per pod, thousand-grain-weight, protein percentage). Macro-mutants can be used directly while polygenic mutants after selection in breeding work.

The book supplied with an appropriate cover, detailed index of authors and brief subject index is recommended primarily to plant breeders, but plant growers and geneticists can also find interesting parts in it.

L. DANIEL

Z. KIRÁLY, Z. KLEMENT, F. SOLYMOSY, J. VÖRÖS: *Methods in Plant Pathology.* With special reference to breeding for disease resistance. Akadémiai Kiadó, Budapest 1970, 129 illustrations; pp. 1–509.

In modern phytopathological research it is essential to have a large number of laboratory, microtechnical, glasshouse as well as field experimental methods. Such methods and descriptions of procedures are collected and presented by the authors in this volume in a didactic form. In the introductory part of each chapter morphology, biology and host-parasite relations of phytopathogenic viruses, bacteria and fungi are discussed, moreover the possibilities of control measures are summarized briefly. The chapter about plant viruses (by F. Solymosy) contains detailed descriptions of symptomatology, genetics and even nomenclature and systematics of viruses, so the actual methods are only dealt with to a comparatively limited extent. An intensive review about symptomatology of bacterioses, modes of identification of plant pathogenic bacteria, moreover problems of bacteriophages can be found in the chapter about phytopathogenic bacteria (by Z. Klement). After the description of general bacteriological methods, special procedures are given using a few test-organisms as example cases for actual investigations. The chapter about mycology (by J. Vörös) is constructed roughly according to similar principles, however, here mainly methods and procedures are described, while general knowledge about morphology and biology of fungi is rightly reduced to a large extent. During the course of the detailed descriptions of certain selected "type" diseases (by Z. Király and J. Vörös) traditional as well as the most modern procedures and investigation methods are given. This chapter includes the most important plant pathogenic fungi, so this is really a useful text for junior plant pathologists. Finally a separate chapter deals with methods in breeding for resistance against phytopathogenic fungi (by Z. Király). This part of the volume contains theories as well as modern data about hostparasite relationships, too.

The book is well printed and richly illustrated, moreover, supplemented with an excellent bibliography, so the volume can be really used by beginners as well as by specialists in almost all fields of phytopathology and plant breeding. Publication of this useful methodological guide is a definite benefit to research workers, plant breeders, teachers and students equally.

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University of Agricultural Sciences

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The book deals with plant pathological methods used in laboratory and field experiments. In addition, the authors exemplify the most important experimental procedures on types of plant diseases. The information is discussed from the point of view of the life cycle of pathogens, the cultural methods of microorganisms, the methods of artificial inoculation in greenhouse or field experiments, the detection of physiologic races of plant pathogens and the sources of disease resistance. Most of the methods have been used in practice and applied to research in the laboratories and experimental stations of the Research Institute for Plant Protection, Budapest.

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1828

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"Probleme agricole"

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Netherlands Journal of Plant Breeding

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